User's
Manual

EXA FC

Model FC400G
Free Available Chlorine Analyzer
(Non-Reagent Type)

IM 12F5A1-01E

vigilantplant.®

YOKOGAWA
Yokogawa Electric Corporation

IM 12F5A1-01E
4th Edition

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INTRODUCTION

Safety, Protection, and Modification of the Product

- In order to protect the system controlled by the product and the product itself and ensure safe operation, observe the safety precautions described in this user's manual. We assume no liability for safety if users fail to observe these instructions when operating the product.
- If this instrument is used in a manner not specified in this user's manual, the protection provided by this instrument may be impaired.
- If any protection or safety circuit is required for the system controlled by the product or for the product itself, prepare it separately.
- Be sure to use the spare parts approved by Yokogawa Electric Corporation (hereafter simply referred to as YOKOGAWA) when replacing parts or consumables.
- Modification of the product is strictly prohibited.
- The following symbols are used in the product and user's manual to indicate that there are precautions for safety:

⚠ CAUTION

A CAUTION sign denotes a hazard. It calls attention to procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

Notes on Handling User's Manuals

- Please hand over the user's manuals to your end users so that they can keep the user's manuals on hand for convenient reference.
- Please read the information thoroughly before using the product.
- The purpose of these user's manuals is not to warrant that the product is well suited to any particular purpose but rather to describe the functional details of the product.
- No part of the user's manuals may be transferred or reproduced without prior written consent from YOKOGAWA.
- YOKOGAWA reserves the right to make improvements in the user's manuals and product at any time, without notice or obligation.
- If you have any questions, or you find mistakes or omissions in the user's manuals, please contact our sales representative or your local distributor.

Warning and Disclaimer

The product is provided on an "as is" basis. YOKOGAWA shall have neither liability nor responsibility to any person or entity with respect to any direct or indirect loss or damage arising from using the product or any defect of the product that YOKOGAWA can not predict in advance.

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Notes on Hardware

- **Appearance and Accessories**

  Check the following when you receive the product:

  - Appearance
  - Standard accessories

  Contact our sales representative or your local distributor if the product's coating has come off, it has been damaged, or there is shortage of required accessories.

- **Model and Suffix Codes**

  The name plate on the product contains the model and suffix codes. Compare them with those in the general specification to make sure the product is the correct one. If you have any questions, contact our sales representative or your local distributor.

- **Before Measurement**

  The FC400G Free Available Chlorine Analyzer is preset with defaults prior factory shipment. Before measurement, verify that these factory default settings meet the operating conditions and if necessary, reconfigure parameters. For details of setting data, refer to chapters 5 and 6.
  When user changes the operation parameter, it is recommended to note down the changed data.

Symbol Marks

Throughout this user's manual, you will find several different types of symbols are used to identify different sections of text. This section describes these icons.

WARNING

Identifies instructions that must be observed in order to avoid physical injury and electric shock or death of the operator.

CAUTION

Identifies instructions that must be observed in order to prevent the software or hardware from being damaged or the system from becoming faulty.

IMPORTANT

Indicates that operating the hardware or software in this manner may damage it or lead to system failure.

NOTE

Identifies important information required to understand operations or functions.

◆ After-sales Warranty

■ **Do not modify the product.**

■ **During the warranty period, for repair under warranty carry or send the product to the local sales representative or service office. Yokogawa will replace or repair any damaged parts and return the product to you. Before returning a product for repair under warranty, provide us with the model name and serial number and a description of the problem. Any diagrams or data explaining the problem would also be appreciated.**

- If we replace the product with a new one, we won't provide you with a repair report.
- Yokogawa warrants the product for the period stated in the pre-purchase quotation Yokogawa shall conduct defined warranty service based on its standard. When the customer site is located outside of the service area, a fee for dispatching the maintenance engineer will be charged to the customer.

■ **In the following cases, customer will be charged repair fee regardless of warranty period.**

- Failure of components which are out of scope of warranty stated in instruction manual.
- Failure caused by usage of software, hardware or auxiliary equipment, which Yokogawa Electric did not supply.
- Failure due to improper or insufficient maintenance by user.
- Failure due to modification, misuse or outside-of-specifications operation which Yokogawa does not authorize.
- Failure due to power supply (voltage, frequency) being outside specifications or abnormal.
- Failure caused by any usage out of scope of recommended usage.
- Any damage from fire, earthquake, storms and floods, lightning, disturbances, riots, warfare, radiation and other natural changes.

■ **Yokogawa does not warrant conformance with the specific application at the user site. Yokogawa will not bear direct/indirect responsibility for damage due to a specific application.**

■ **Yokogawa Electric will not bear responsibility when the user configures the product into systems or resells the product.**

■ **Maintenance service and supplying repair parts will be covered for five years after the production ends. For repair for this product, please contact the nearest sales office described in this instruction manual.**

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Model FC400G
Free Available Chlorine Analyzer (Non-Reagent Type)

IM 12F5A1-01E 4th Edition

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REVISION INFORMATION i

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1. OVERVIEW

In recent years, measuring and monitoring the concentration of free available chlorine in water distribution has become increasingly important for obtaining safe drinking water.

The FC400G free available chlorine analyzer (non-reagent type) is a process-use free available chlorine analyzer utilizing a rotating electrode polarographic method for measurement. Commercialized with minimum maintenance as a primary theme, the FC400G can continuously measure the free available chlorine concentration without reagent use.
When you attempt to measure free available chlorine and the test solution contains combined chlorine, there's an error which depends on the concentration of the combined chlorine. To reduce the error in this sort of situation, we recommend that you use the combined chlorine insensitive version of the Model FC400G that has been developed for this purpose. Compared with the standard Model FC400G, the electrodes, the beads, and the applied voltage are different, but the unit is otherwise the same as the standard Model FC400G as regards measurement principles, installation, specifications and performance.
Figure 1.1 shows the appearance of the FC400G free available chlorine analyzer.

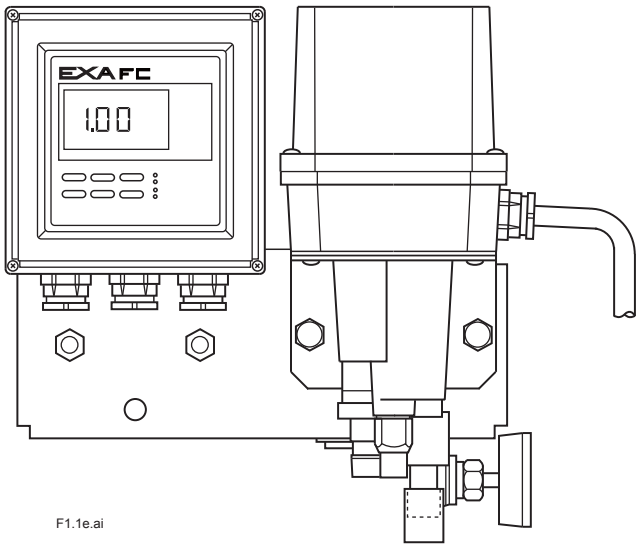

Figure 1.1 FC400G Free Available Chlorine Analyzer.

1.1 Configuration of the Free Available Chlorine Analyzer

The FC400G free available chlorine analyzer is broadly divided into a free available chlorine analyzer main body (FC400G) and a sampling system: The main body consists of a detector and converter, and the sampling system consists of sample water piping and a needle valve.

<Free Available Chlorine Analyzer Main Body>

The detector consists of a measuring tank and electrode mechanism block. The detector electrolytically reduces free available chlorine in the sample water supplied to the measuring tank to obtain a diffusion current in the plateau region. It also generates signals for automatic temperature compensation of this diffusion current that varies with temperature. The measuring tank is made of acrylic resin and contains ceramic beads in the part where a indicator electrode is inserted, for polishing the electrode.

The electrode mechanism block incorporates an indicator electrode (rotating electrode), counter electrode (Pt 1000 Ω RTD-built-in silver chloride electrode), and driving mechanism consisting of a synchronous motor that rotates the indicator electrode at a constant speed, and a belt.

The converter's measuring circuit is housed together with an operation panel and external wiring connection terminal board in a closed aluminum casing. This measuring circuit performs amplification and computation based on two signals from the detector to generate an output signal of 1 to 5 V DC or 4 to 20 mA DC corresponding to the output range.

<Sampling System>

The FC400G sample inlet should have a pressure of 1 to 150 kPa a flow rate of 0.1 to 2.5 l/min. Sample meeting these conditions can be directly introduced to the measuring tank. However, measurement of sample not meeting such conditions requires installation of a sampling system to supply the required conditions.

YOKOGAWA's dedicated sampling system (ST401G) allows measurement of sample with a pressure of 100 to 750 kPa and flow rate of 0.1 to 10 l/min.

1.2 Measuring Principle of FC400G Free Available Chlorine Analyzer

The FC400G free available chlorine analyzer applies the polarographic method using a rotating electrode, as the measuring principle to measure free available chlorine existing in the form of chlorine (Cl_2), hypochlorous acid (HClO), and hypochlorite ions (ClO^-).

The FC400G applies external voltage between the indicator electrode (rotating electrode) and counter electrode (silver chloride electrode) to electrolytically reduce free available chlorine, and then measures the diffusion current flow during the above voltage application to obtain the concentration of free available chlorine. The voltage to be applied is selected from among values in the area where current value remains stable even if the voltage value changes, i.e., the area (plateau area) where concentration polarization occurs in polarography. Since this applied voltage changes according to the diffusion current value, the FC400G free available chlorine analyzer performs compensation complying with this change, to apply suitable voltage. Further, this obtained diffusion current value also changes with temperature, and the current is automatically corrected using signals from the RTD (Pt 1000 Ω) built in the counter electrode.

The FC400G free available chlorine analyzer was designed to require minimal maintenance and uses no reagent. However, it must be understood that there are restrictions on the conditions of the water to be measured (sample) in comparison with the RC400G Residual Chlorine Analyzer that uses reagent. Also, note that if combined chlorine is present in sample, FC400G performance is affected.

Figure 1.2 shows the measuring circuit principle of the FC400G free available chlorine analyzer. The FC400G applies voltage compensated in accordance with the diffusion current value, between the indicator and counter electrodes and measures the diffusion current flow between the electrodes. Temperature compensation is accomplished using the CPU which performs calculation based on the temperature signals received from the temperature-measuring circuit.

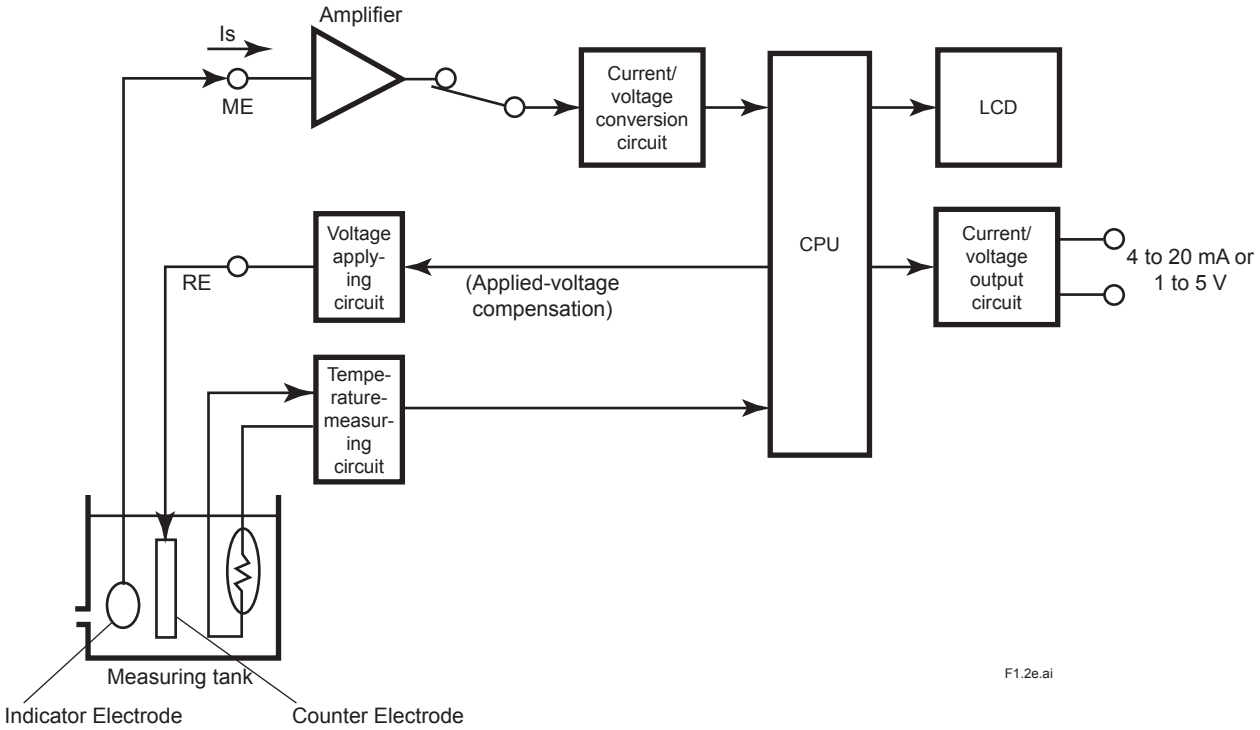

Figure 1.2 Measuring Circuit Principle

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2. SPECIFICATIONS

2.1 Standard Specifications

2.1.1 FC400G Free Available Chlorine Analyzer (Non-Reagent Type)

Measured Object: Free chlorine in tap water

Measuring System: Polarographic method using rotating electrode

Display Method: Digital (3 1/2 digit LCD) display

Measuring Range: 0 to 3 mg / l

Output Range: Can switch between arbitrary ranges(each between 0 to 1 mg/l and 0 to 3 mg/l). Default ranges at shipping time are:

Range 1: 0 to 2 mg/l, Range 2: 0 to 3 mg/l

Output Signal: 4 to 20mA DC (load resistance :550Ω or less) or 1 to 5V DC (output resistance : 300Ω or less), isolated

Contact Output: 2 points, Dry contact

Event of Error; Excessive diffusion current value, measured temperature error, applied voltage error, converter error, and temperature compensation range over

Maintenance; Any modes other than measurement (MEAS) mode

Contact capacity; 250 V AC max., 1 A max., 125 VA max. (resistance load)
220 V DC max., 1 A max., 60 W max. (resistance load)

	Main unit power OFF	Main unit power ON	
	–	During non- operation	In operation
Event of Error	Open	Closed	Open
Maintenance	Closed	Open	Closed

Contact Input: Remote range switching:
Switching between 2 preset ranges (range 1 and range 2)
0 V DC or contact open: Range 1
5 V DC (input impedance 250 kΩ): Range 2

Sample Conditions:

Temperature; 0 to 50 °C (Temperature compensation range; 0 to 40 °C)

pH; 6.5 to 7.5 (see Figure 2.1)

Flow Rate; 0.1 to 2.5 l/min

Pressure; 1 to 150 kPa
100 to 750 kPa
(for the case where dedicated sampling system ST401G is provided)

Conductivity; 100 to 300 µS/cm (see Figure 2.2)

SS (Suspended Solid); 10 mg/l or less

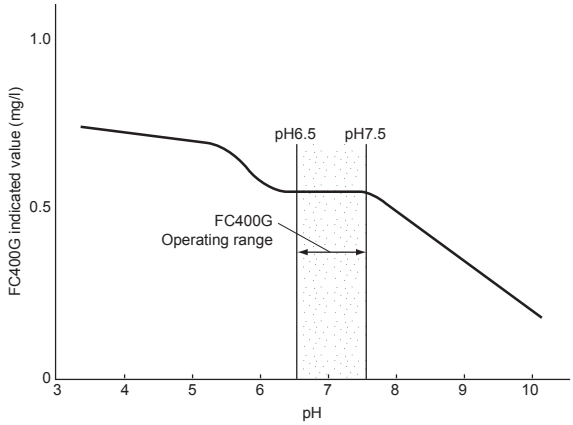


Figure 2.1 Sensitivity characteristics of diffusion current by pH value

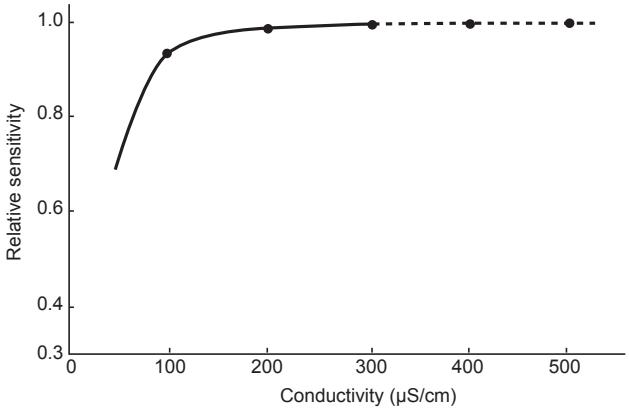


Figure 2.2 Sensitivity characteristics of diffusion current by conductivity

Note: If conductivity exceeds 300 µS/cm, default value of applied voltage should be changed.

Electrodes :

Indicator electrode; Indicator electrode
The combined chlorine insensitive version uses a gold alloy indicator electrode.

Counter electrode ; Silver chloride electrode (with Pt 1000 RTD installed)

Electrode Cleaning : Ceramic bead cleaning
The combined insensitive version uses glass beads.

Converter Functions :

Display functions; Concentration, sample temperature, applied voltage, diffusion current, output signal %, zero point, slope, error display, interactive message, and key operation request display

Diagnostic function; Excessive diffusion current value, measured temperature error, applied voltage error, converter error, temperature compensation range over, zero point error, slope abnormality, and response error

Functions settable/executable during operation level; Zero and span calibration, selection of message area display content, hold ON/OFF selection, cell motor ON/OFF selection

Functions settable/executable in setting level; Output range setting, hold parameter setting, wash/auto-calibration parameter setting, plateau characteristic measurement

Service level code entry Functions settable/ executable during service level; Switching of °C/°F, temperature compensation range over check ON/OFF, straight line/two line-segment output selection, applied voltage setting, and applied voltage compensation rate setting

Main Wetted Part Materials:

Measuring tank; Acrylic resin

Piping; Flexible PVC and hard PVC

Color: Munsell 0.6GY3.1 / 2.0 and Munsell 2.5Y8.4 / 1.2

Painting Finish: Baked polyurethane resin coating

Ambient temperature: -10 to 55°C

Ambient humidity: 5 to 95% RH (no dew condensation allowed)

Storage Temperature: -30 to 70°C

Installation: Indoor (Outdoor use separately requires rainproof measures.) (Direct sunlight must be avoided.)

Utility:

Power supply; 100 V AC ±10% 50/60 Hz
110 V AC ±10% 50/60 Hz
200 V AC ±10% 50/60 Hz
220 V AC ±10% 50/60 Hz

Power consumption; Approx. 15 VA

Mounting: 2B pipe mounting or wall mounting

Weight: Approx. 6 kg

2.1.2 Dedicated Sampling System for (Non-Reagent Type) Free Available Chlorine Analyzer

Function: Used for application having high pressure and large flow rate.
Refer to GS 12A00V02-01E.

2.2 Characteristics

(% display shows value relative to the upper limit of a range.)

Repeatability: 2 %

Linearity: ±5 %

Drift: Zero drift; ±1 % / month
Span drift; -10 % / month

Response time: Approx. 2 min (90% response time)

Temperature compensation error (water temperature): ±3% (Temperature compensation range : 0 to 40°C)

Ambient temperature effects: ±0.5% / 10°C

Power variation effects: ±0.5% / 10% of rated voltage

Combined chlorine effects of the combined chlorine insensitive version:
Approx. 30% of combined chlorine concentration

2.3 Model and Codes

2.3.1 Free Available Chlorine Analyzer (Non-Reagent Type)

Model	Suffix Code	Option Code	Description
FC400G	----------	----------	Free available chlorine analyzer (non-reagent type)
Output signal	- 5 - 6	---------- ----------	1-5 V DC 4-20 mA DC
Power supply	1 2 3 4 5 6 7 8	---------- ---------- ---------- ---------- ---------- ---------- ---------- ----------	200 V AC±10%, 50 Hz 200 V AC±10%, 60 Hz 220 V AC±10%, 50 Hz 220 V AC±10%, 60 Hz 100 V AC±10%, 50 Hz 100 V AC±10%, 60 Hz 110 V AC±10%, 50 Hz 110 V AC±10%, 60 Hz
—	*A	----------	Style A
Optional specifications		/ PPM / SCT / ST / SPS / CC	Units in ppm With Tag Plate With ST401G Sampling system (Note 1) With Teflon-coated screws for protection from salt corrosion Combined chlorine insensitive version

(Note 1) Specified /ST to use with sampling system.

Accessories

Name	Part No.	Q´ty	Remarks
Polishing powder (Alumina)	K9088PE	1 Bottle	For cleaning of indicator electrode
Ceramic beads (Note1)	K9332ZP	2	2 bags / 1 Q' ty
Fuse	A1111EF	4	2A (spare)
Allen wrench	L9827AB	1 Set	Nominal size : 1.5 mm
Allen wrench	L9827AT	1 Set	Nominal size : 2 mm

Note1: Glass beads is used in case of combined chlorine insensitive version.

2.3.2 Sampling System

Model	Suffix Code	Option Code	Description
ST401G	.....	.....	Sampling system
System (note 3)	-FC4 -PH4 -PH5 -PF4 -PF5	....	With free available chlorine analyzer (FC400G) (note 1) With pH converter (PH400G) (note 2) With pH converter (PH450G) (note 2) With free available chlorine analyzer (FC400G) and pH converter (PH400G) (note 1) (note 2) (note 3) With free available chlorine analyzer (FC400G) and pH converter (PH450G) (note 1) (note 2) (note 3)
Ultrasonic oscillator (for pH meter)	-N -U	....	Not supplied Supplied
——	-A	.....	Always -A
Option		/R /AN /S /ARS /AZC1 /AZC2 /AZC3 /AZC4 /RR /SCT /TT3	Piping connections on the back Without instrument With stainless steel stand (note 4) With arrester (power and signal lines only) (note 5) With auto zero calibration for 100 V AC (note 6) With auto zero calibration for 110 V AC (note 6) With auto zero calibration for 200 V AC (note 6) With auto zero calibration for 220 V AC (note 6) With remote range switching (note 7) With stainless tag plate With 500 ml KCl reserve tank for pH sensor (note 2)

Model ST401G refers only to a sampling system and does not include a free available chlorine analyzer and/or a pH meter (sensor,holder,converter and ultrasonic oscillator). (Instrument should be purchased separately.)

Note that the ST401G Sampling System accepts the following models of note 1 or note 2 only, and depending on system configuration.

Note 1: Non-reagent type free available chlorine analyzer (refer to GS 12F5A1-E)
When ordering, option code "/ST" (integration into ST401G sampling system) must be specified.
Note 2: 4-wire type pH converter system (refer to GS 12B7C1-E, GS 12B07C05-01E, GS 12B07B02-E,GS 12J05C02-00E)

pH sensor:	PH8EFP-03-TN-TT1-N-T*A (when suffix code of "-PH4", "-PF4" specified.)
	PH8EFP-03-TN-TT3-N-T*A (when suffix code of "-PH4", "-PF4" and option code of "/TT3" specified.)
	PH8EFP-03-TN-TT1-N-G*A (when suffix code of "-PH5", "-PF5" specified.)
	PH8EFP-03-TN-TT3-N-G*A (when suffix code of "-PH5", "-PF5" and option code of "/TT3" specified)
pH holders:	PH8HF-PP-JPT-T-NN-NN*A (without cleaning system)
	PH8HF-S3-JPT-T-NN-NN*A (without cleaning system)
	PH8HF-PP-JPT-T-S3-C1*A (with ultrasonic cleaning)
	PH8HF-S3-JPT-T-S3-C1*A (with ultrasonic cleaning)
pH converter:	PH400G-☐-EA*B (when suffix code of "-PH4", "-PF4" specified.)
	PH450G-A-E (when suffix code of "-PH5", "-PF5" specified.)
Ultrasonic oscillator:	PUS400G-NN-NN-☐-E (which power supply rating should be same as the pH converter.)

Note 3: Power supply rating of non-reagent type free available chlorine analyzer should be same as the pH converter.
Note 4: Specify if needed, instead of the standard stanchion made of carbon steel.
Note 5: Available only when the suffix code "-FC4","-PH4" or "-PH5" is specified.
Note 6: Available when free available chlorine analyzer is specified singly or in combination with pH meter, by suffix code, "-FC4", "-PF4" or "-PF5."
Note 7: Available when free available chlorine analyzer is specified singly by suffix code, "-FC4." An arrester is supplied automatically with this option.

2.3.3 Spare Parts

Name	Part No.	Description	Q´ty	Recommended replacement interval (*)
Indicator Electrode (Rotating electrode)	K9332MB	Gold electrode	1	Yearly
Indicator Electrode (Rotating electrode)	K9334JP	Gold alloy indicator electrode	1	Yearly
Counter Electrode	K9332MK	Silver chloride electrode	1	(*1)
Ceramic Beads	K9332ZP	For cleaning general type indicator electrode, 2 bags	1	Yearly
Glass Beads	K9332ZJ	For cleaning combined chlorine insensitive type indicator electrode, 2 bags / 1Q' ty	1	Yearly
Polishing Powder (Alumina)	K9088PE	For polishing indicator electrode	1	Yearly
Brush	K9332JX	Part for electrode mechanism	1	2 years
Slip Ring	K9332JZ	Part for electrode mechanism	1	2 years
Fuse	A1111EF	2A	1	Yearly
Driven Shaft Assembly	K9334JV	Part for electrode mechanism	1	3 years
O-Ring	Y9115XB	Part for electrode mechanism	1	3 years
Drive Belt	L9804UK	Part for electrode mechanism	1	3 years
Motor Assembly (100 V)	K9334JY	Part for electrode mechanism	1	3 years
Motor Assembly (110 V)	K9334VQ	Part for electrode mechanism	1	3 years
Motor Assembly (200 V)	K9334VR	Part for electrode mechanism	1	3 years
Motor Assembly (220 V)	K9334VS	Part for electrode mechanism	1	3 years
Gear Head (100 V/110 V)	K9332JP	Part for electrode mechanism	1	3 years
Gear Head (200 V/220 V)	K9334VA	Part for electrode mechanism	1	3 years
Activated Charcoal Filter	L9862AY	For zero calibration	1	Yearly

(*) Replacement intervals vary depending on the application.
(*1) At the time of damage.

2.4 Dimensions

Unit: mm

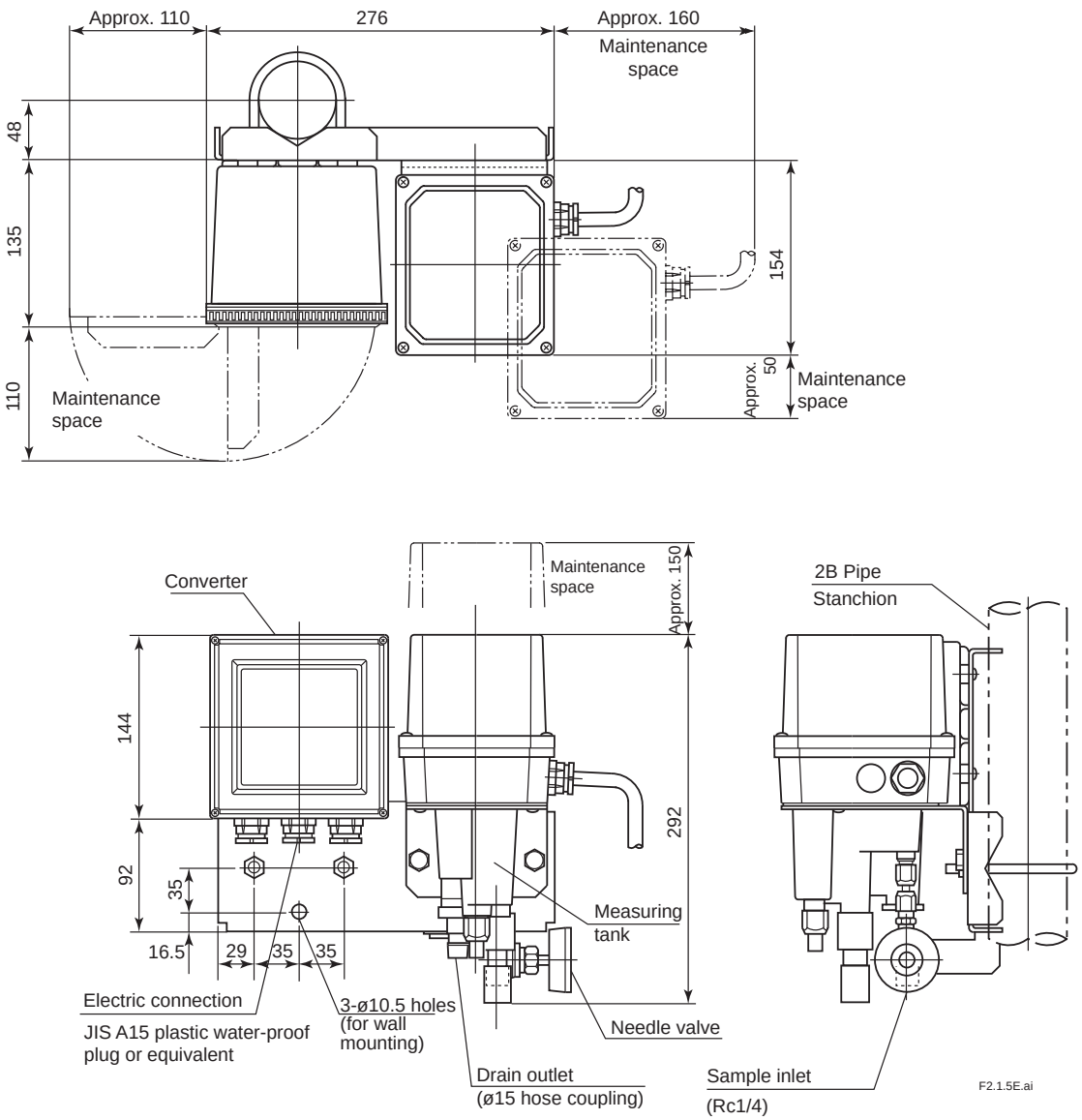


Figure 2.3 Dimensions of the FC400G Free Available Chlorine Analyzer

3. INSTALLATION, PIPING, AND WIRING

3.1 Installation

The FC400G free available chlorine analyzer (non-reagent type) is sufficiently packed for shipment to prevent damage during transportation.

Upon receipt, carefully unpack the FC400G carton near the place of installation.

3.1.1 Installation Site

Install the FC400G free available chlorine analyzer at a location that:

(1) is free from rain water such as an indoor location or in a cabinet,

(2) has low vibration,

(3) has low corrosive gas,

(4) is low humidity,

(5) has low temperature variation and where the temperature is maintained at or as near to room temperature as possible,

(6) allows sufficient maintenance space with easy maintenance access, and

(7) allows drainage.

3.1.2 Mounting

The FC400G Non-Reagent type Free Available Chlorine Analyzer mounts vertically or horizontally on a sturdy pipe (JIS 50A), using U bolts (see diagram). To mount it on a plate or wall, drill M8-size holes, separated by 70 mm, for the U-bolt holes.

Where necessary, use a sampling system to regulate the pressure and flow of the measurement liquid. Normally the FC400G would be mounted in the sampling system in this case.

Figure 3.1 shows a combination of the FC400G with a special sampling system (ST401G-FC4). When using this, refer to its instruction manual IM12A0V2-E regarding installation requirements.

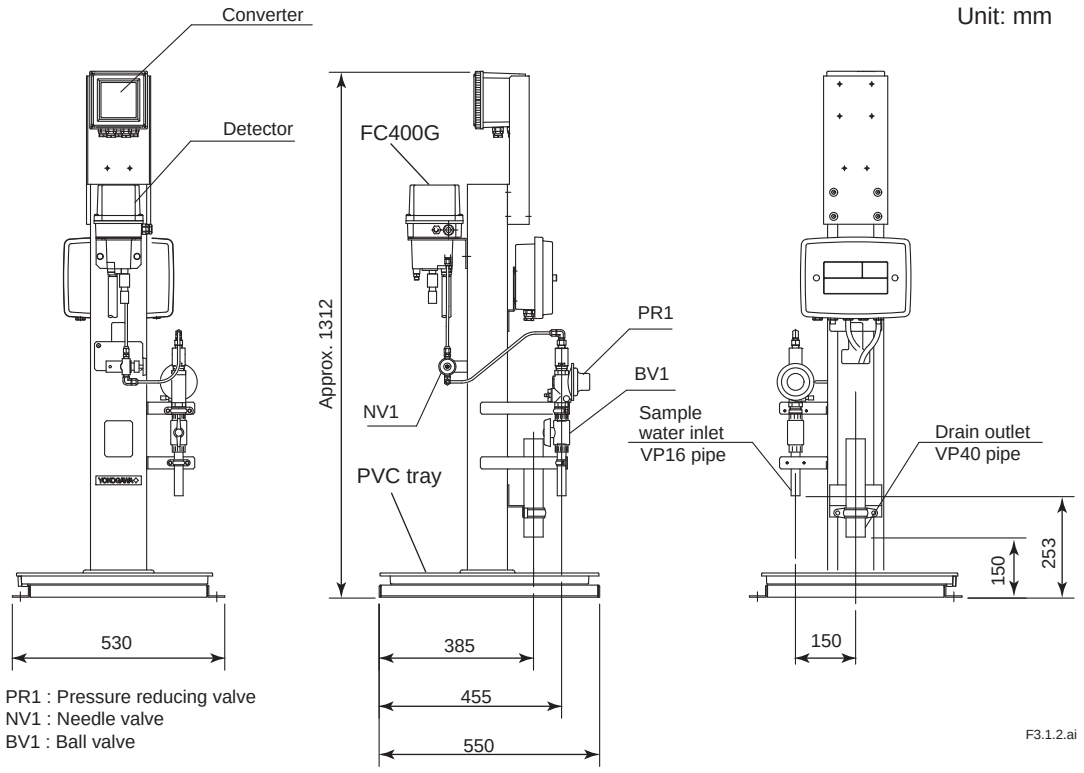


Figure 3.1 Example of ST401G-FC4 Installation

3.2 Piping

3.2.1 For Use without a Sampling System

When sample has a pressure of 1 to 150 kPa and a flow rate of 0.1 to 2.5 l/min, such sample can be directly introduced into the measuring tank. Connect a Ø6 X Ø4 mm polyethylene tube to the sample water inlet.

Connect a Ø22 X Ø15 mm flexible mesh-reinforced tube to the drain outlet from the measuring tank. Install this tube so that no water entrapment is formed. Entrapment of water in the drain tube may cause overflow from the measuring tank.

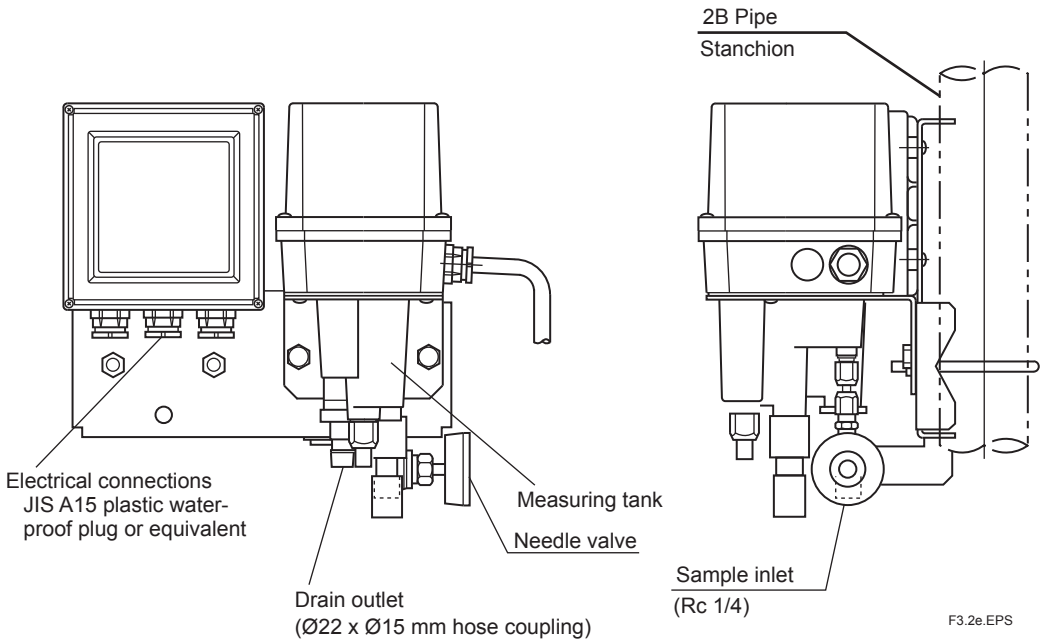


Figure 3.2 Free Available Chlorine Analyzer Piping Connections

3.2.2 For Use with Dedicated Sampling System

Piping is connected to the measurement liquid inlet and drain outlet. The piping will depend on the sampling equipment. When the ST401G sampling system is to be used, refer to its instruction manual IM12A0V2-E.

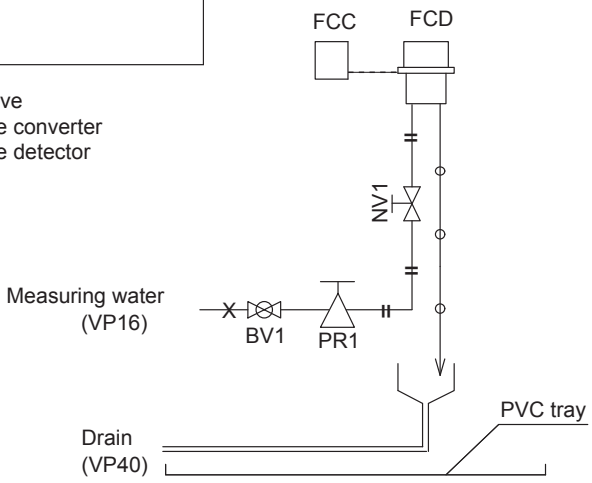
Figure 3.3 shows an example of piping for the ST401G Sampling System.

For details, refer to IM 12A0V2-E Sampling System.

Piping diagram of ST401G-FC4-N-A (With free available chlorine analyzer)

<Tubing materials>
- ϕ6 / ϕ4 Polyethylene tube
- ϕ12 / ϕ9 Polyethylene tube
- ϕ22 / ϕ15 soft tube with net
- VP16 Pipe
- VP40 Pipe

PR1 : Pressure-reducing valve
FCC : Free available chlorine converter
FCD : Free available chlorine detector
NV1 : Needle valve
BV1 : Ball valve



Piping diagram of ST401G-FC4-N-A/AZC□
(With auto zero calibration for free available chlorine analyzer)

<Tubing materials>
- ϕ6 / ϕ4 Polyethylene tube
- ϕ22 / ϕ15 soft tube with net
- VP16 pipe
- VP40 pipe

BV1,2,3 : Ball valve
PR1 : Pressure-reducing valve
FCC : Free available chlorine converter
FCD : Free available chlorine detector
NV1 : Needle valve
F1 : Activated charcoal filter
SV1 : 3-way solenoid valve

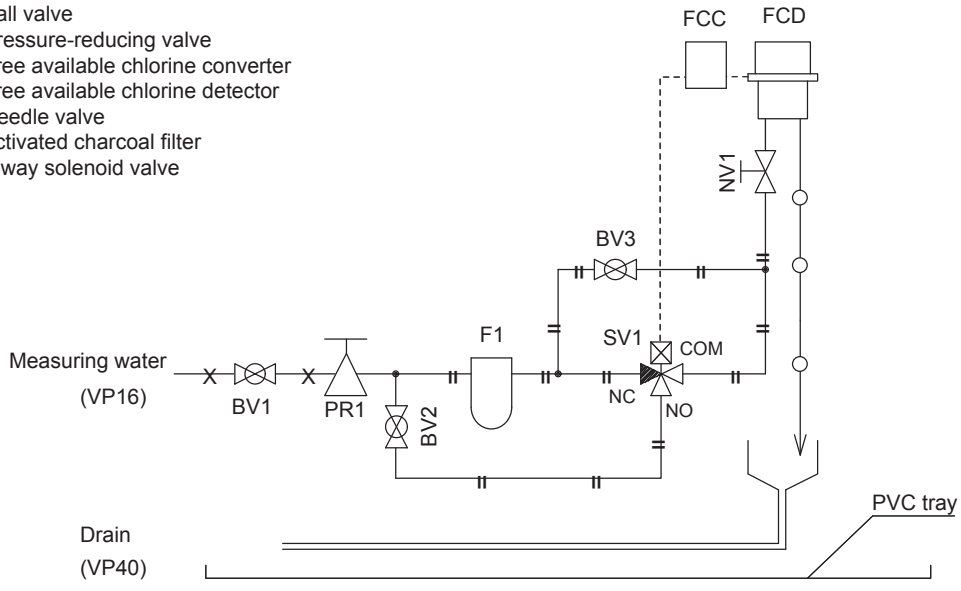


Figure 3.3 Piping Diagram of ST401G Sampling System

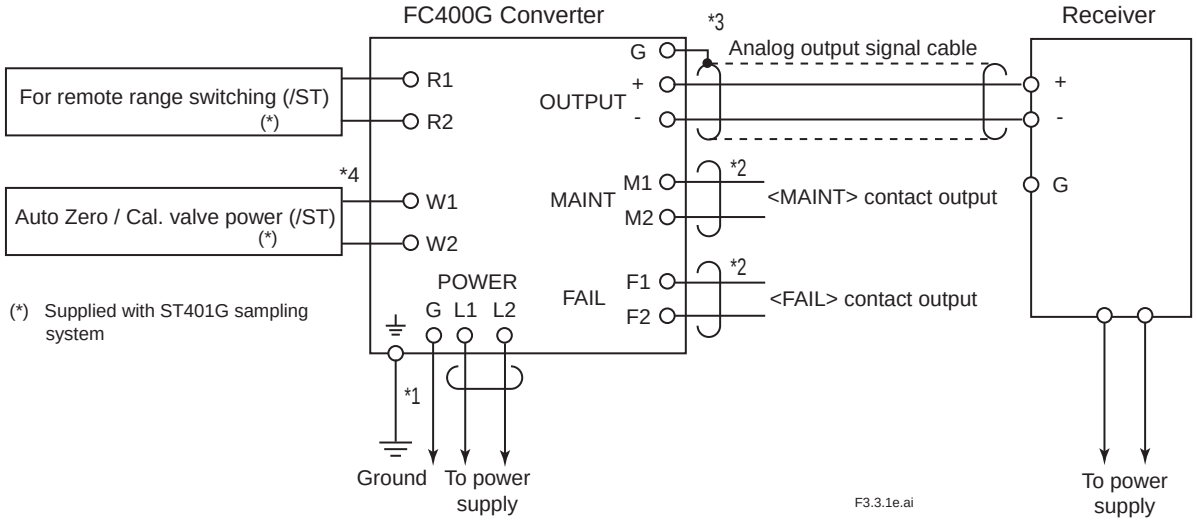
3.3 Wiring

The types of wiring required by the FC400G free available chlorine analyzer (non-reagent type) are as shown below. All are connected to wiring terminals (M3 screw) in the converter.

(1) Power cable and grounding wire

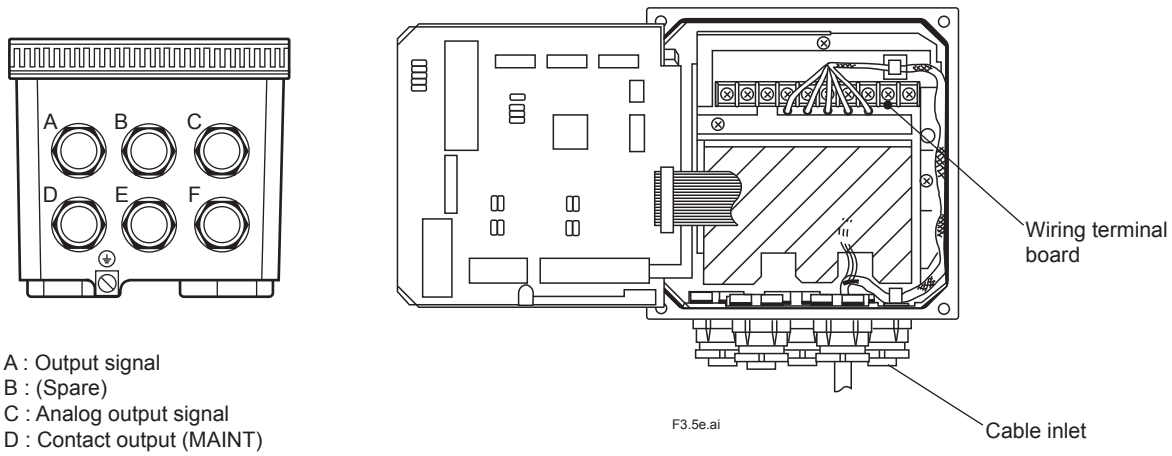
(2) Analog output signal cable

(3) Contact output (<MAINT>, <FAIL>) cables (when required)



(Note) All are connected to wiring terminals (M3 screw) in the converter.
*1: Be sure to ground the case ground terminal (M4 screw), or if this is not possible then connect to G of power wiring. Avoid two-point ground. (Case is connected to signal ground inside converter).
*2: Use cable with 9 to12 mm OD.
*3: Use two-core shielded cable with 9-12 mm OD. To avoid two-point ground, connect shield to ground at one end only
*4: Contact input to be applied the voltage.

Figure 3.4 External Wiring Diagram



A : Output signal
B : (Spare)
C : Analog output signal
D : Contact output (MAINT)
E : Contact output (FAIL)
F : Power input

Figure 3.5 Converter's External Wiring Terminal Board and Cable Inlet

The converter has five external wiring cable inlets. In general, use one cable for each wiring line.

Note: Unused cable inlets must always be provided with cable gland with blind plug.

3.3.1 Power Cable and Grounding Wire

A power cable is used to feed power whose voltage and frequency meet the specifications for the FC400G free available chlorine analyzer converter and a grounding wire to ground the converter case.

For the power cable, use a two-core cable with a finished O.D. of 9 to 12 mm to connect the power supply to converter terminals L1 and L2. The converter has no power switch; it is recommended that a double-pole single-throw switch be installed in the power line.

Process the end of the cable to be connected to the converter as follows:

(1) Remove insulation covering from the cable for approx. 80 mm from the end of the cable.

(2) Connect crimp-on terminal lugs for M3 screws to the ends of the core conductors.

Install a grounding wire using the " ⏚ " grounding terminal on the left bottom of the converter case. The grounding terminal uses an M4 screw. Connect a grounding conductor that is has been terminated is a lug (so that sufficient continuity is obtained) to this terminal to provide grounding (grounding resistance of 100 Ω or less).

Note: If grounding using the converter case grounding terminal is difficult, connect the grounding wire to terminal G (M3 screw) in the converter to make grounding on the power side. This requires that a three-core or two-core shielded cable be used as a power/grounding cable.

3.3.2 Analog Output Signal Cable

An analog output signal cable is used to transmit an output signal of 1 to 5 V DC or 4 to 20 mA DC corresponding to the output range to a receiver such as a recorder.

For analog output signals, use a two-core shielded cable with a finished O.D. of 9 to 12 mm.

Process the end of the cable to be connected to the converter as follows:

(1) Remove insulation covering and shield from the cable up to approx. 40 mm from the end of the cable. Solder a lead wire to the root of the exposed shield and protect the soldered area by wrapping with insulation tape.

(2) Cut the lead wire to the length of the core conductors and connect a crimp terminal lug for with M3 screws to the end of this lead wire and the conductors.

(3) Connect the cable to the converter's terminals + and - the positive side conductor of the cable must be connected to the " + " of the OUTPUT terminal and the negative side conductor to the " - " of the OUTPUT. Also, connect the shield lead wire to terminal G.
(Do not attempt to ground the shield on the receiver side.)

3.3.3 Contact Output Cables

These cables are used to output <FAIL> and <MAINT> contact signals from the converter.

For contact output, use cables with a finished O.D. of 9 to 12 mm (select a two- or four-core cable depending on the number of contact outputs to be used). The contact capacity of contact output relays is as shown in Table 3.1. Devices to be connected must meet the conditions in Table 3.1.

Table 3.1 Contact Output Relay's Contact Capacity

	For DC	For AC
Maximum allowable contact voltage	220 V	250 V
Maximum allowable contact current	1 A	1 A
Maximum allowable contact power	60 W	125 VA

Connect the core conductors of cables to terminals F1 and F2 (<FAIL,> contact output) and to terminals M1 and M2 (<MAINT> contact output). Before connecting cables, process the ends of the cables as follows: Remove approx. 40 mm of cable insulation covering from the end to be connected to the converter and install a crimp terminal lug for an M3 screw on each conductor.

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4. PARTS NAMES AND OPERATIONS

4.1 Parts Names and Functions

<Detector>

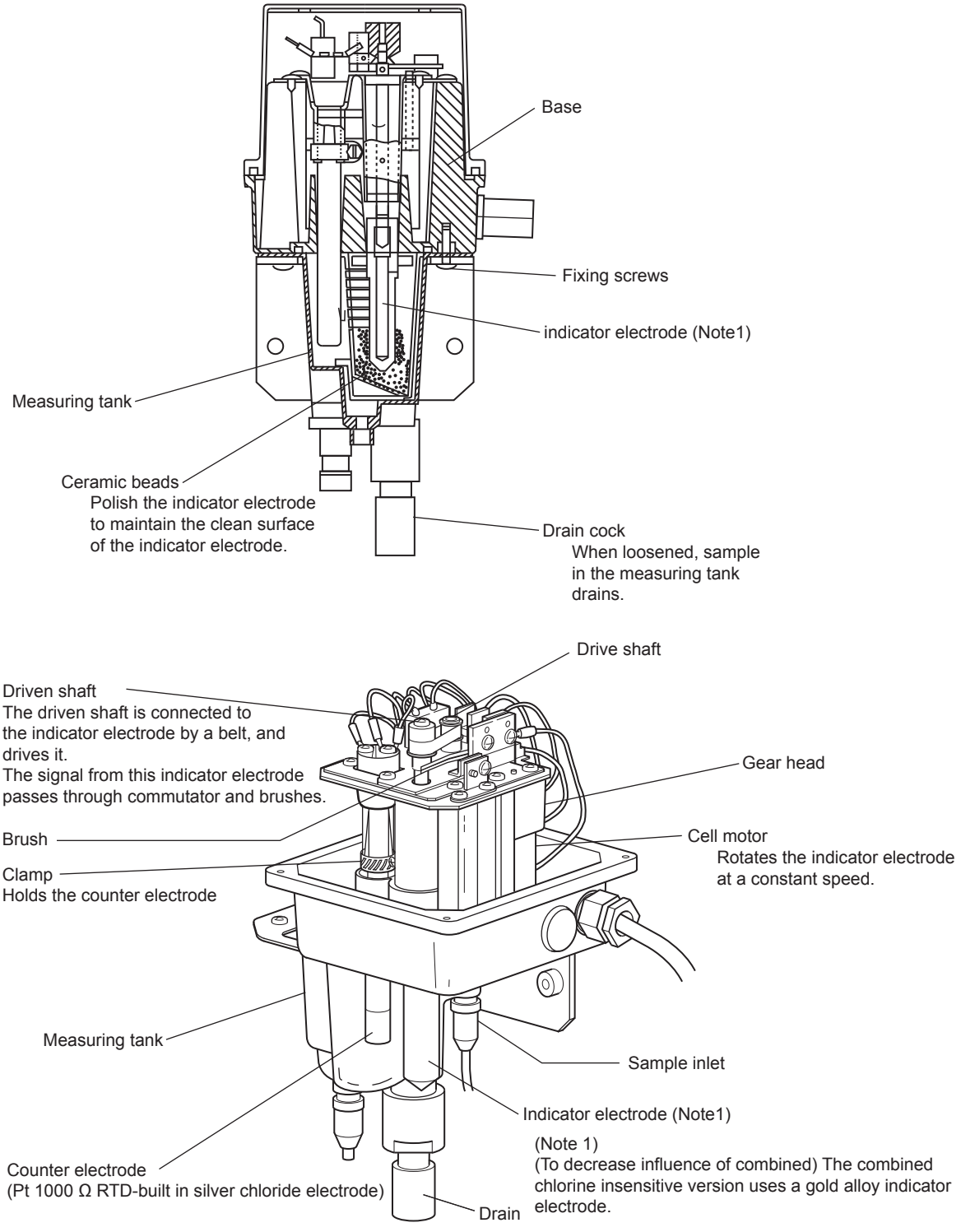

Base
Fixing screws
indicator electrode (Note1)
Measuring tank
Ceramic beads
Polish the indicator electrode to maintain the clean surface of the indicator electrode.
Drain cock
When loosened, sample in the measuring tank drains.
Drive shaft
Driven shaft
The driven shaft is connected to the indicator electrode by a belt, and drives it.
The signal from this indicator electrode passes through commutator and brushes.
Gear head
Brush
Cell motor
Rotates the indicator electrode at a constant speed.
Clamp
Holds the counter electrode
Measuring tank
Sample inlet
Indicator electrode (Note1)
(Note 1)
(To decrease influence of combined) The combined chlorine insensitive version uses a gold alloy indicator electrode.
Counter electrode
(Pt 1000 Ω RTD-built in silver chloride electrode)
Drain
F4.1e.ai

Figure 4.1 Detector Parts Names and Functions

<Converter>

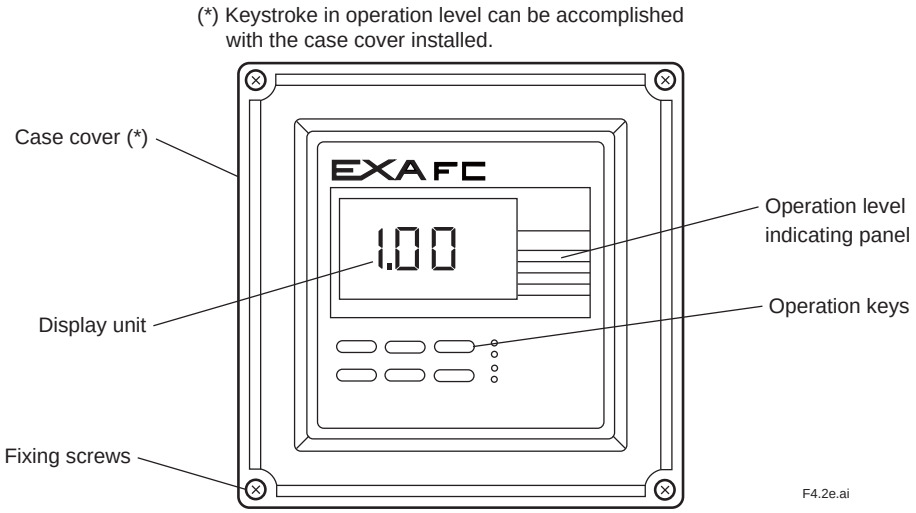


Figure 4.2 Converter Parts Names (with the Cover Closed)

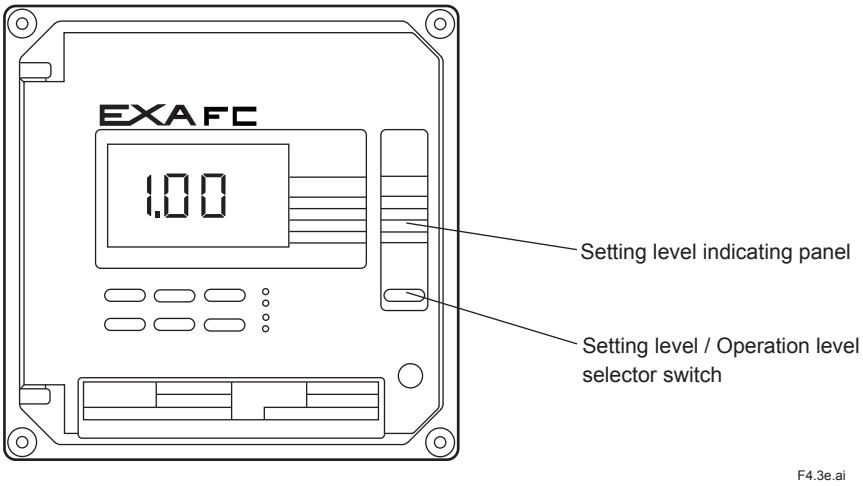
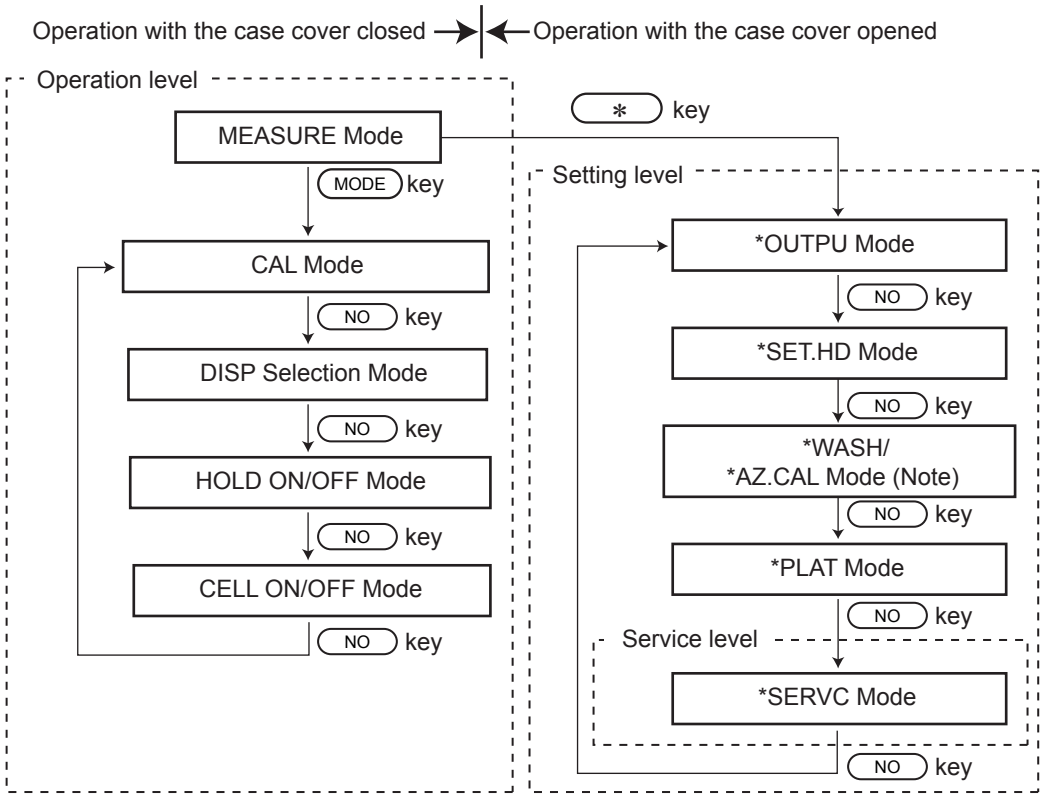


Figure 4.3 Converter Parts Names (with the Cover Opened)

4.2 Operation Modes and Codes



- When entering desired mode, push YES key.
- MODE key can be used for returning MEASURE mode as ESC key.

(Note) Change mode by code 09.

The operation of the FC400G free available chlorine analyzer (non-reagent type) is determined in the following three control levels.

(1) Operation level

(2) Setting level

(3) Service level

The operation level applies to daily inspection or maintenance. Keystroke in this level can be accomplished with the converter case cover installed.

The setting and service levels are used to select a function and set data. Function selection and data setting are generally made once before starting operation. Also, inadvertent change of such selection or setting should be prevented; operation keys used for the setting level or service level cannot be externally accessible. To change such selection or setting, remove the converter case cover.

4.2.1 Modes in Operation level

The FC400G can enter or exit from the operation level using the key. The operation level has the following modes.

(1) MEASURE : Allows mg/l (or ppm) and auxiliary indications.

(2) CAL : Calibrates zero-point and span.

(3) DISP : Allows selection of the message area display content. Temperature, diffusion current, applied voltage, output, slope, and zero point

(4) HOLD : Selects HOLD ON/OFF.

Note If *HLD.OF is set in the setting level, entry into the HOLD mode is not available.

(5) CELL : Selects cell motor ON/OFF.

4.2.2 Modes in Setting level

Press the ✳ key to switch from Measurement to Setting mode, and press the MODE key to exit Setting and revert to Measurement mode. Select the Setting mode from the following :

(1) *OUTPU : Range setting (concentration values corresponding to 50% and 100% output). Both range 1 and range 2 are set.

(2) *SET .HD : Turn HOLD ON / OFF, select HOLD output (previous value, preset value).

(3) *WASH : Select Manual or Auto Wash, select Timer ON / OFF, set wash interval, wash time, and stabilization (settling) time. (Since the FC400G does not use reagent, washing is not provided and wash mode is not used in the standard instrument).

*AZ.CAL : Set Auto-Zero calibration, select Timer ON / OFF, set wash interval,wash time, and stabilization (settling) time.

(4) *PLAT : Plateau characteristic measurement / data read out, initial applied voltage, step applied voltage, set number of steps.

(5) *SERVC : Enter service level code (refer to Sec. 4.2.3)

4.2.3 Modes in Service level

Enter the setting level using ✳ key. Then, press the NO key to call the<*SERVC> mode and press the YES key to enter the service level. The service level has the following codes required to set various data.

Code		
01	*TEMP :	Selects °C or °F
02	*FAIL :	Selects temperature compensation range exceeding fail ON/OFF.
04	*ΔT.SEC :	Sets stability determination parameter ΔT.
	*ΔPPM :	Sets stability determination parameter ΔPPM.
	*CT.min :	Sets stability determination parameter. CT
05	*NONLN :	Selects linear output or two-line-segment output.
07	*DRV V :	Sets applied-voltage compensation parameter Start.
	*V/μA :	Sets applied-voltage compensation parameter Slope.
08	*CHANG :	Selects electrode sensitivity initialization ON/OFF.
09	*WA / CA :	Select Wash or Auto-Zero calibration.
10	*R.RNGE :	Turn ON/OFF Remote Range Selection.

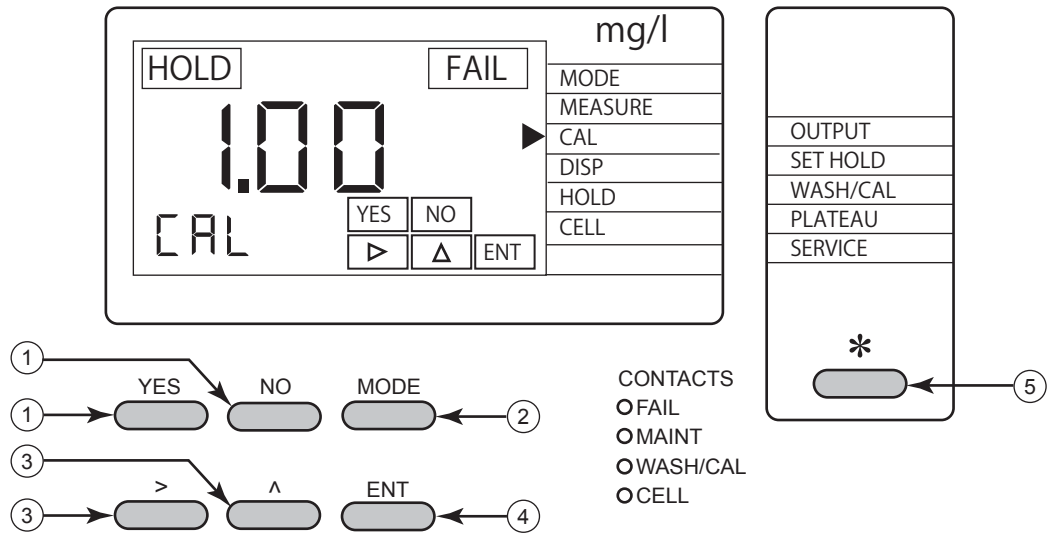
Press MODE key to exit from service level.

(Note) If you accidentally enter codes other than 01, 02, 04, 05, 07, 08 and 10 (for example, 80), immediately press the MODE key to exit from service level.

5. NAMES OF COMPONENTS

All keys on the FC400G free available chlorine analyzer (non-reagent type) are available in an interactive manner. This allows easy operation that can be accomplished in accordance with displayed message indicator and operation key indicator.

5.1 Operation Keys



1 YES NO : Used to respond to a message by pressing YES or NO.

2 MODE : Used to select to operation mode from measurement mode or to return measurement mode from modes of each level.

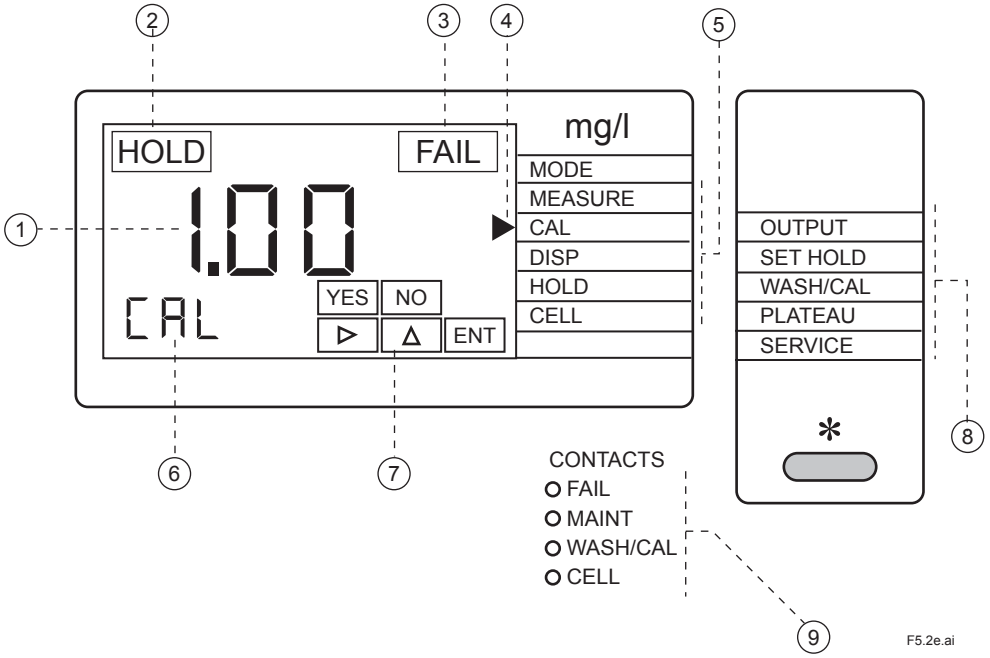
3 > ^ : Used to set data.

4 ENT : Pressing this key sets an entered value.

5 * : Used to select the setting level from MEASURE mode.

F5.1e.ai

5.2 Display Content on the Display Unit



① Data Area : Displays measured data and set data.

② HOLD : Appears if the FC400G is in hold status.

③ FAIL : Appears if failure occurs.

④ Mode Pointer : Points to the currently selected mode. When the pointer is lit, it indicates that the relevant mode has been selected. If the pointer blinks, it indicates that the FC400G is not yet in that mode.

⑤ Modes in the Operation Level

⑥ Message Indicator : Displays data other than the measured concentration value, and messages required for interactive operation.

Note: Appearance of " * " at the head of a message means that the FC400G is in the setting/service level.

⑦ Operation Key Indicator : Indicates key(s) required for interactive operation with respect to the displayed message.

⑧ Types of Modes in the Setting Level / Service Level

⑨ Operation Status Display LED : Displays terminal operation status on the LED

- FAIL
- MAINT

} Lights when contacts operated.

- WASH/CAL
- CELL

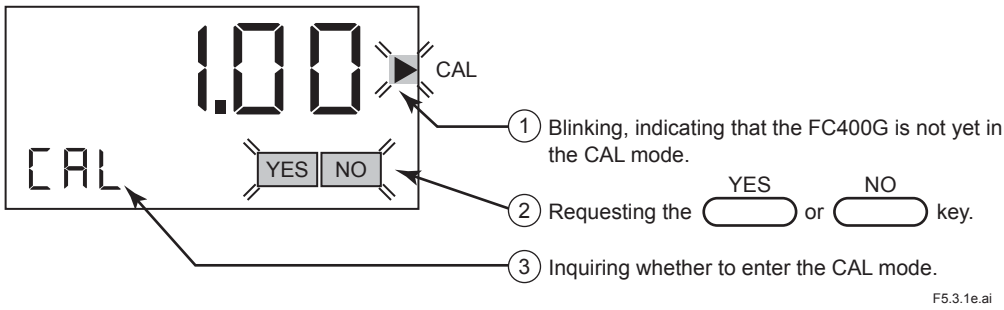
} Lights in the corresponding mode (power applied).

5.3 Basic Key Operation

5.3.1 Key Operation When [YES] [NO] Indication Blinks

If the [YES] [NO] indication blinks in the operation key indicator (② in the figure below), press the (YES) or (NO) key to response to the message displayed on the message area (③ in the figure).

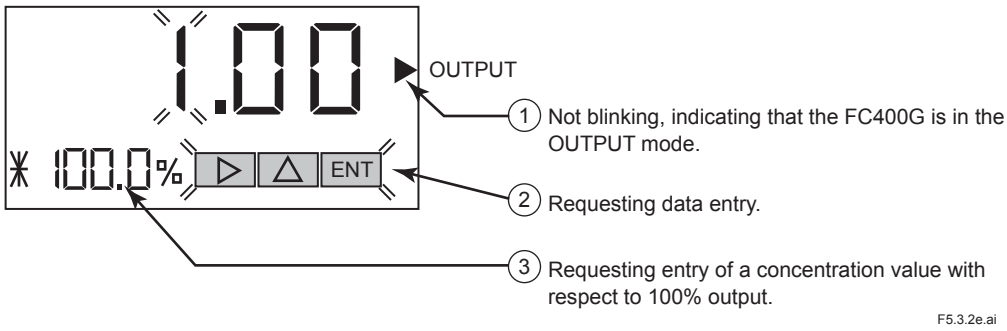
(Example)



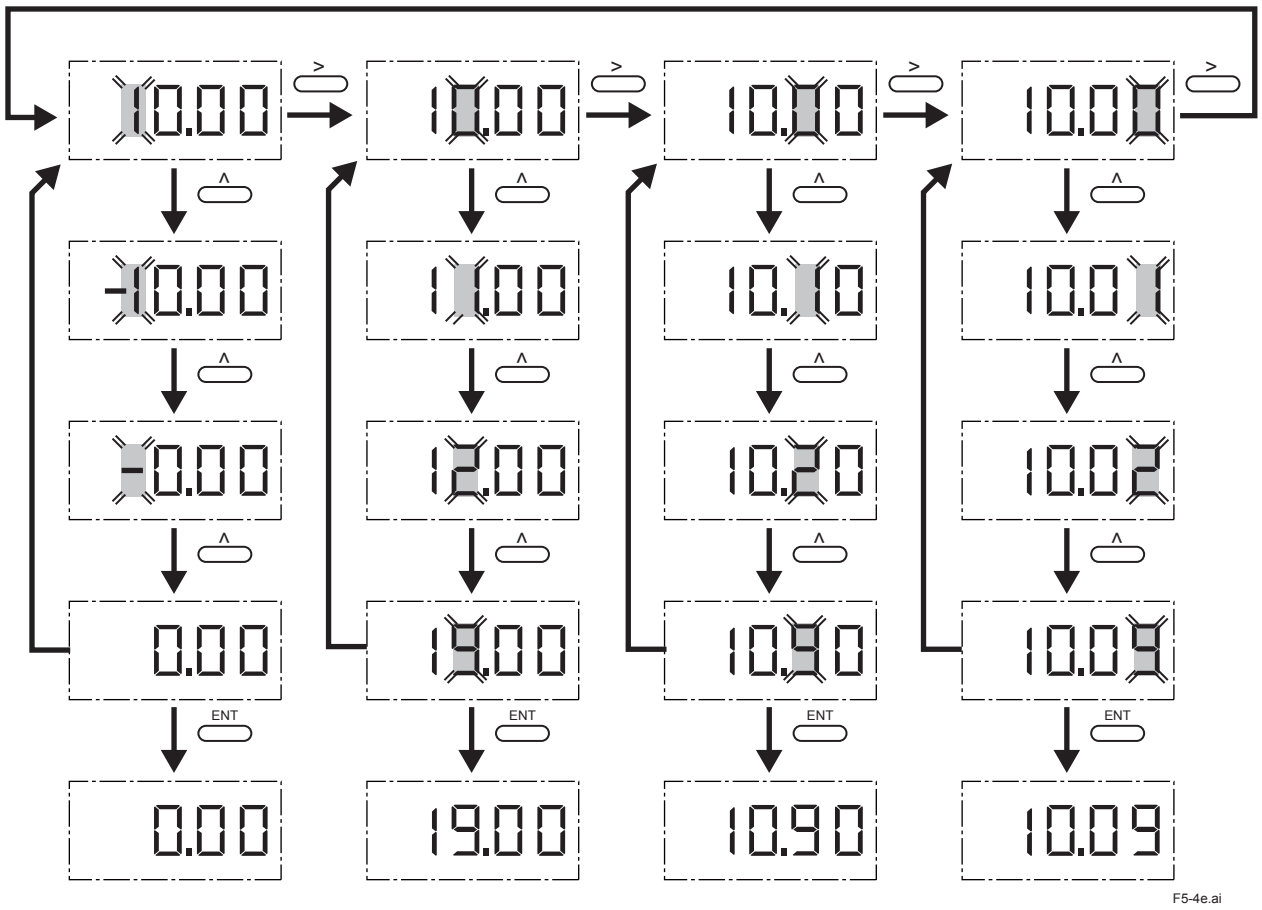
5.3.2 Key Operation When [▷] [△] [ENT] Indication Blinks

If the [▷] [△] [ENT] indication blinks in the operation key indicator, data entry is required corresponding to the message displayed in the message area. Use the (>) key to shift the blinking along digits in the data area, increase the value of a blinking digit using the (∧) key, and finally set it using the (ENT) key.

(Example)



Example of Data setting using the ∧ and > keys



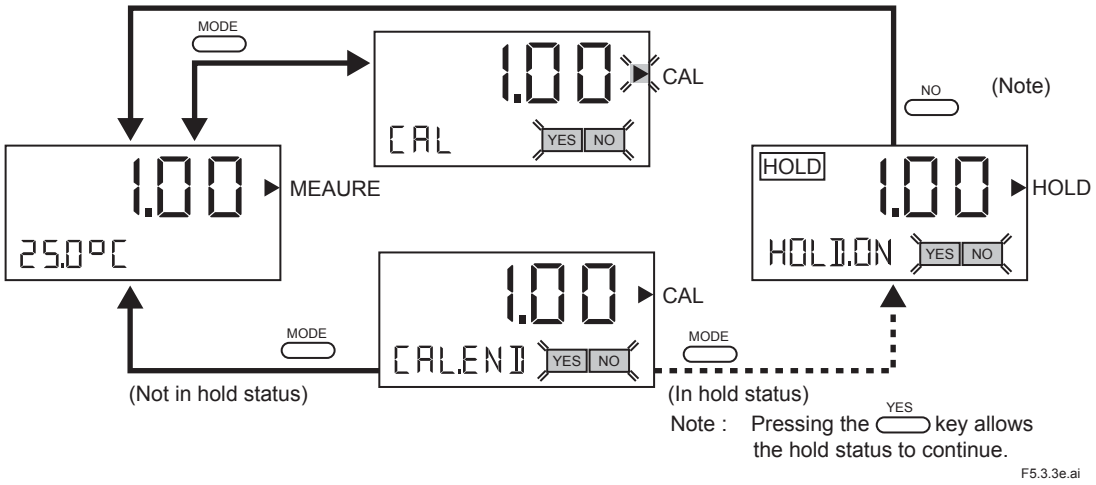
5.3.3 Mode Selection in the Operation Level

To enter from the measurement mode to another mode in the operation level or to return from any mode to the measurement mode, press MODE key. In the operation level the FC400G can return from any status to the measurement mode except in the following cases.

(1) During calibration (mode selection is not accepted until calibration ends)

(2) In hold status after completion of calibration (<HOLD> is selected)

(Example)



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5.3.4 Transfer to the Setting Level

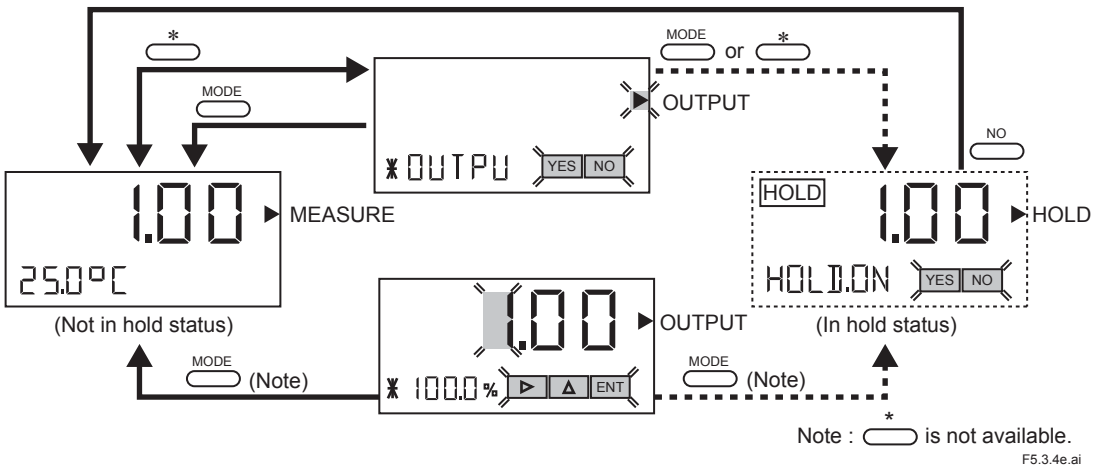
Unscrew four fixing screws to remove the converter case cover. Press the ✳ key to select the setting level from measurement mode.

To return from the setting level to the measurement mode in the operation level, press the ✳ or MODE key.

However, if the FC400G is in the hold status, transfer to the measurement mode is disabled, the FC400G returns to the <HOLD> mode.

Note: The ✳ key is available only when the FC400G is not yet in any mode in the setting level.

(Example)



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5.3.5 Transfer to the Service Level

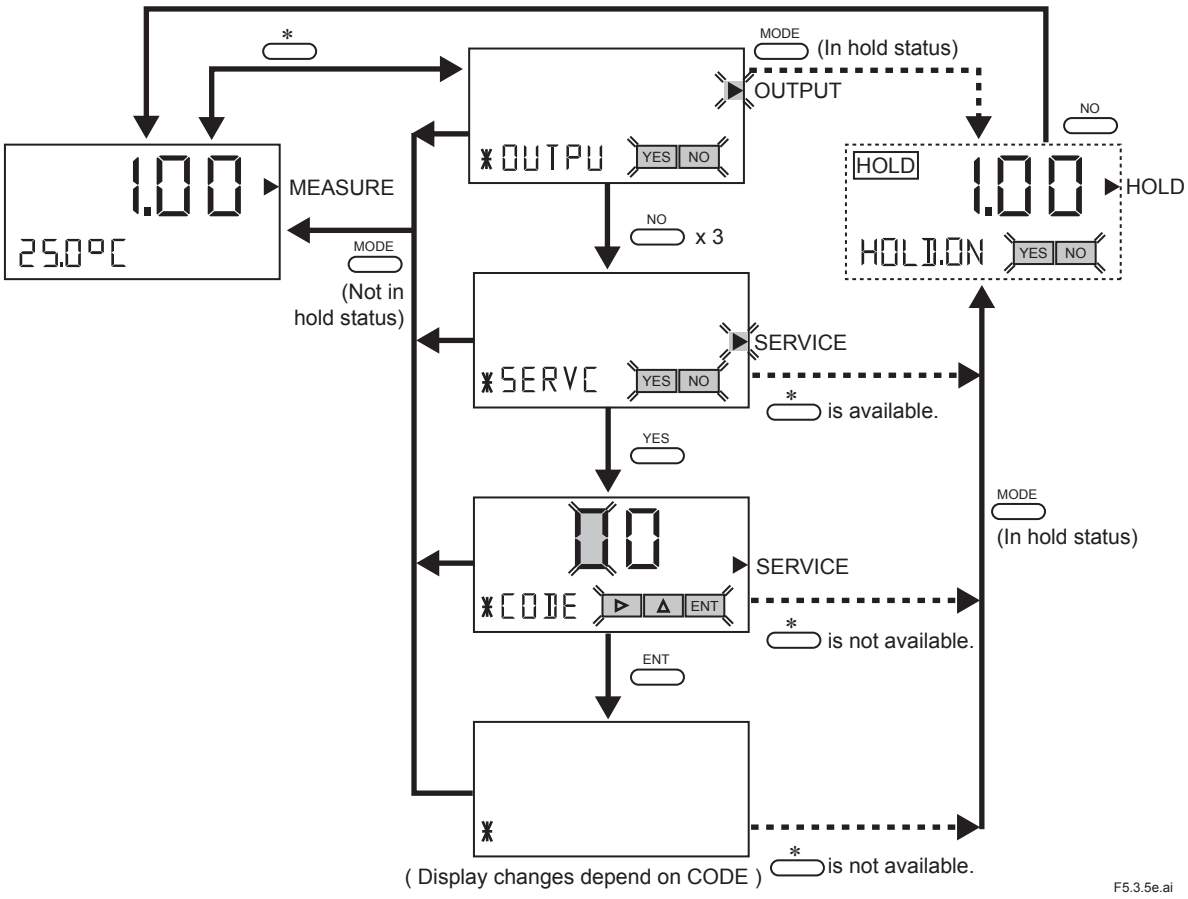
Press the ✳ key to select the setting level from measurement mode.

Next press the NO key to call " *SERVC " and press the YES key to enter the service level. Then enter a code.

To return from the service level to the measurement mode in the operation level, press the MODE key.

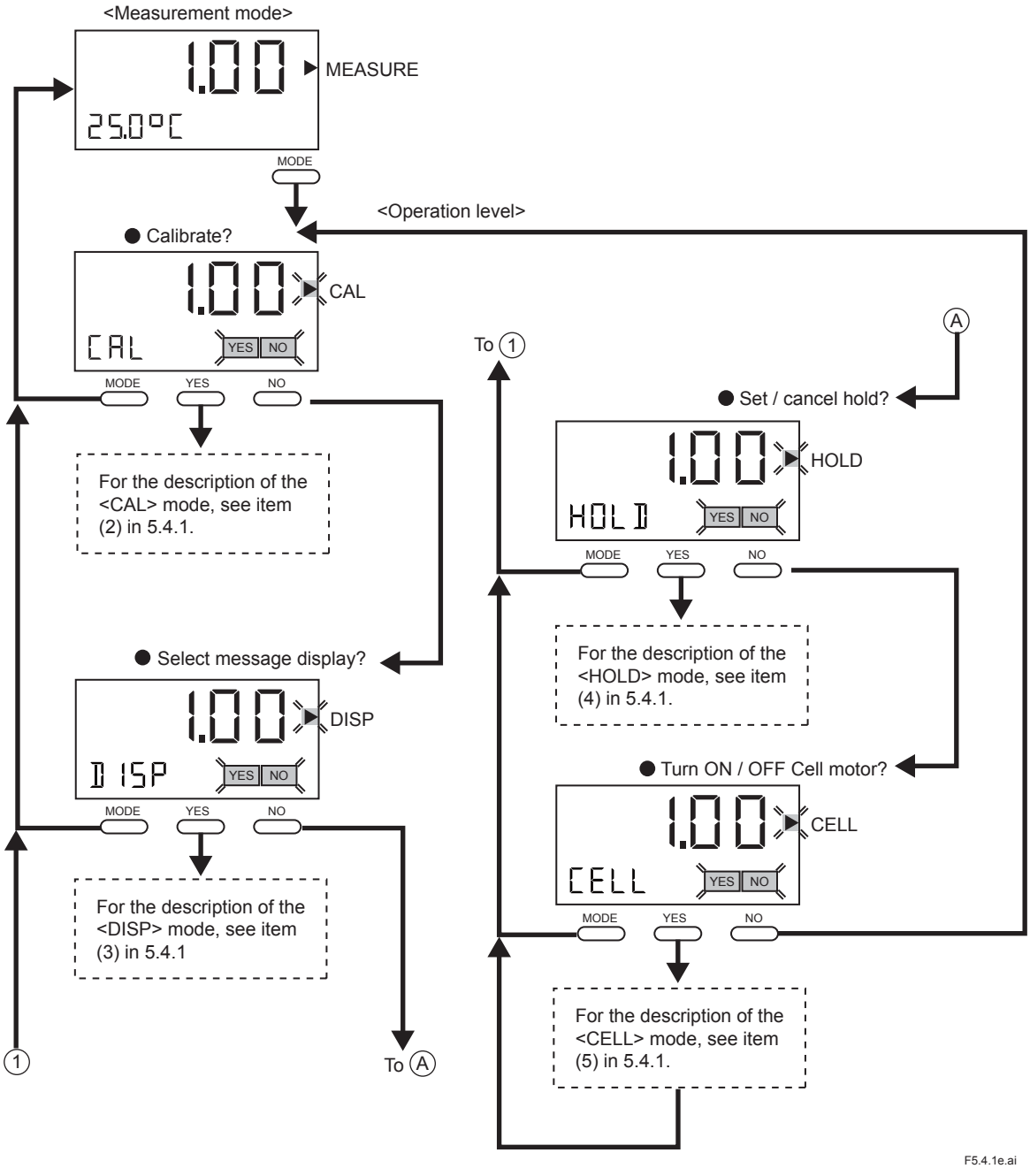
However, if the FC400G is in the hold status, transfer to the measurement mode is disabled and the FC400G returns to the <HOLD> mode.

(Example)



5.4 Mode Selecting Procedure for Each Level and Mode Content

5.4.1 Mode Selection in the Operation Level



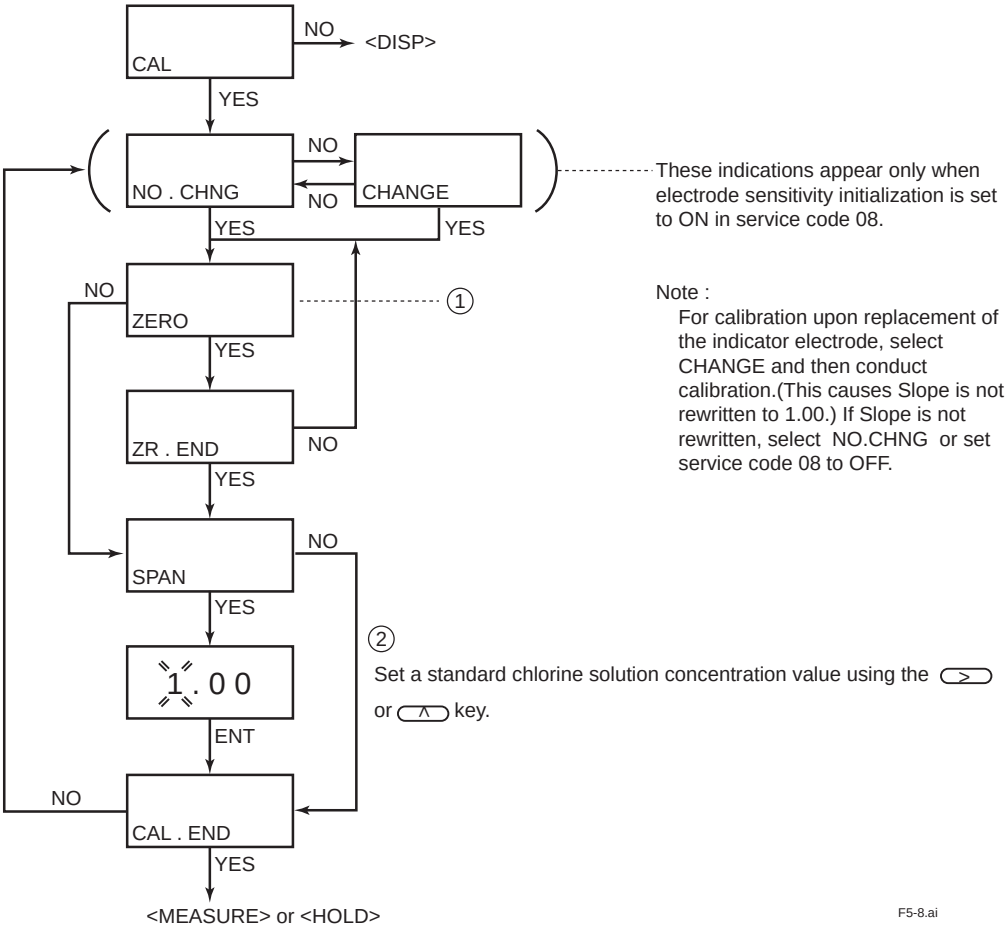
(1) <MEASURE> (Measurement Mode)

Allows concentration and message indications (one of temperature, diffusion current, applied voltage, output, slope, or zero point).

(2) <CAL> (Calibration Mode)

Press the MODE key in measurement mode and enter the operation level.

Press the YES key in message indicator CAL to select the <CAL> mode.



At ① pressing the YES key causes mg/l (or ppm) indication to blink, starting automatic zero calibration. When the calibration ends, “ZR.END” appears.

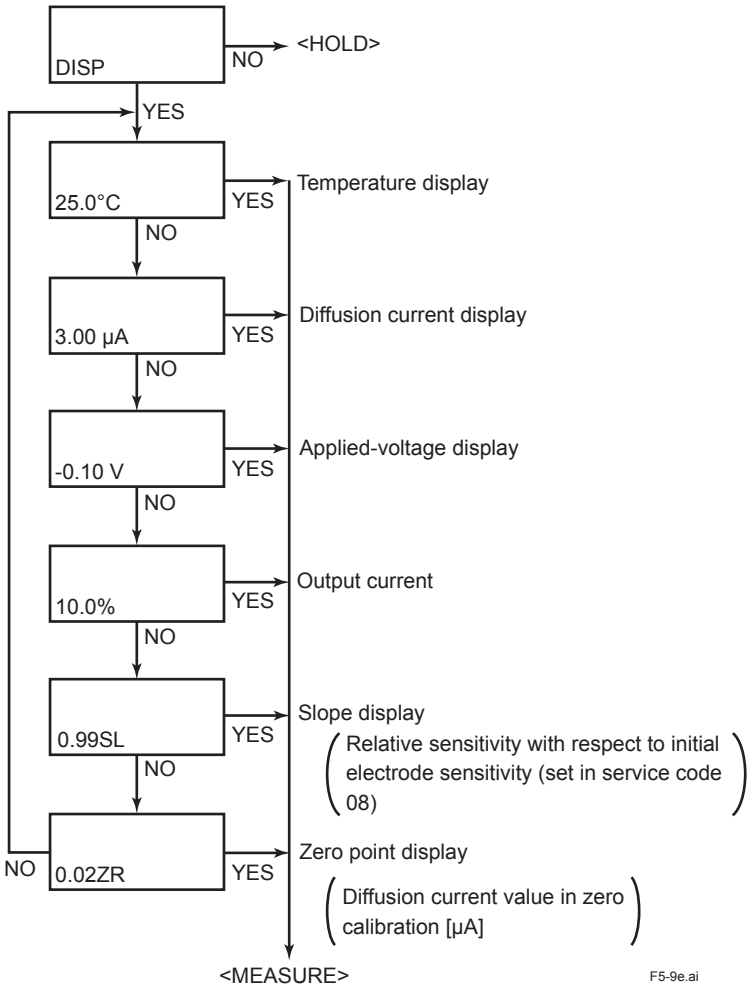
At ② , select a calibration solution concentration value using the > or ^ key.

Press the ENT key. This causes mg/l (or ppm) indication to blink, starting automatic span calibration. When the calibration ends, “CAL.END” appears.

(3) <DISP> (Message Display Selection Mode)

Press the MODE key and select the <DISP> mode using the YES / NO key.

Select the message display content using the YES / NO key. Temperature (°C / °F), diffusion current (µA), applied voltage (V), output (%), slope (SL), or zero point (ZR) can be displayed.



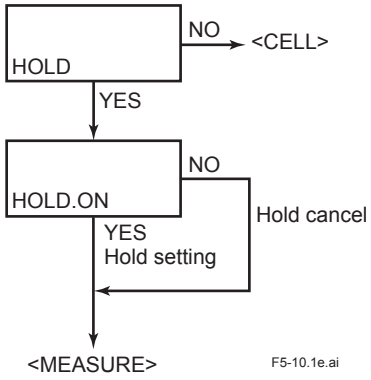
(4) <HOLD> (Hold ON/ OFF Mode)

Unless "*HLD.ON" is established in the setting level, the FC400G cannot enter this mode.

Press the MODE key and select the <HOLD> mode using the YES /NO key.

Select setting or canceling with "HOLD.ON" displayed (press the YES key to set the <HOLD> mode or the NO key to cancel it).

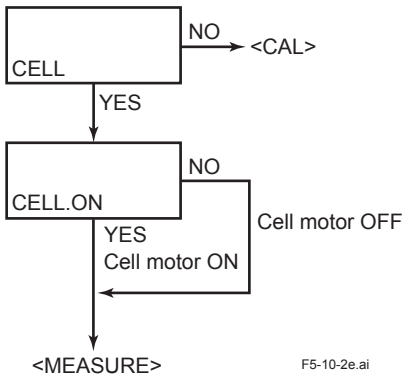
In the hold mode, the LCD displays the HOLD indication.



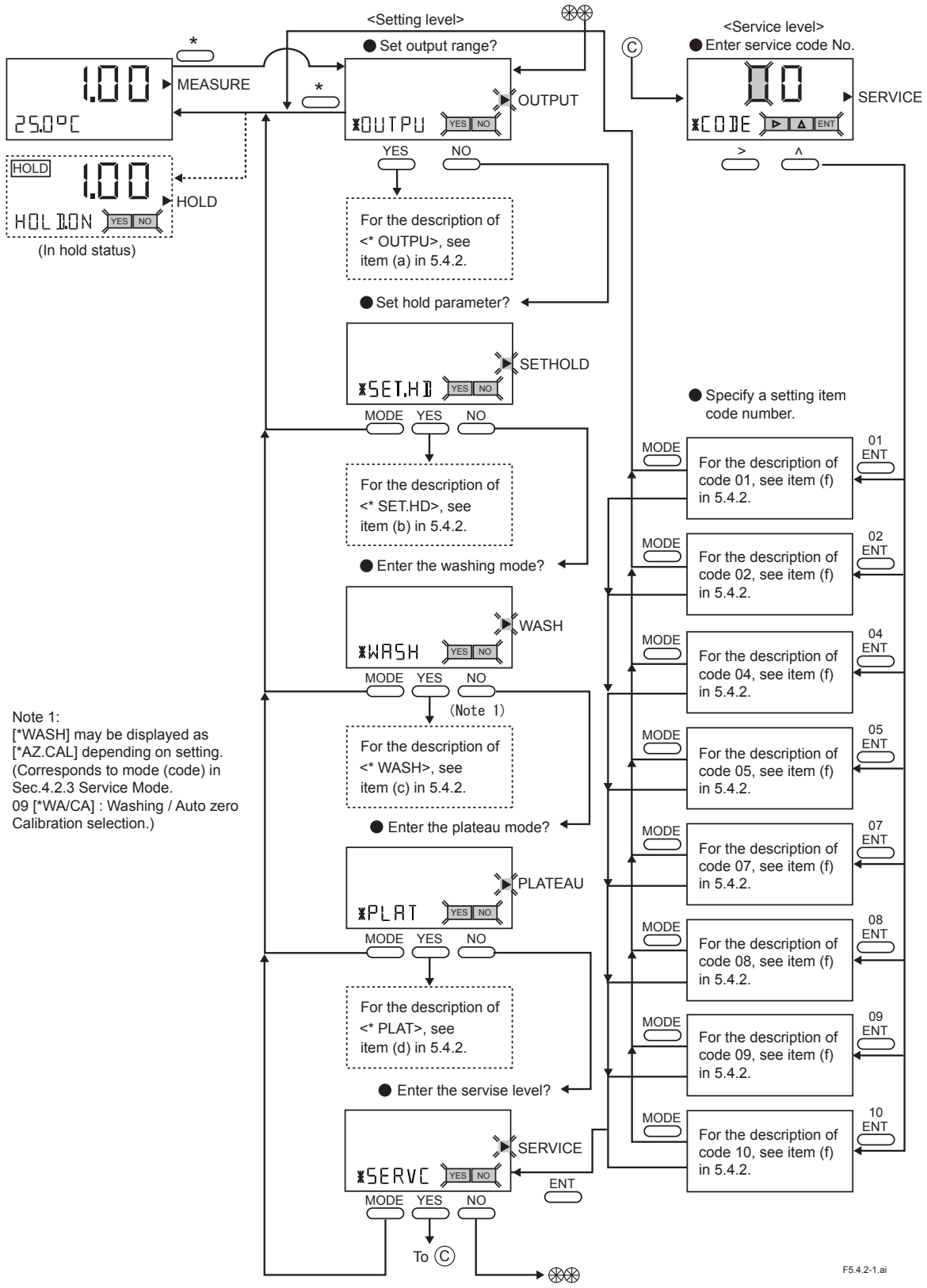
(5) <CELL> (Cell Motor ON / OFF Mode)

Press the MODE key and select the <CELL> mode using the YES / NO key.

Select ON or OFF with "CELL.ON" displayed (press the YES key to turn the motor ON or NO key to turn it OFF).



5.4.2 Modes in the Setting/Service Level and Selection of Their Setting Items

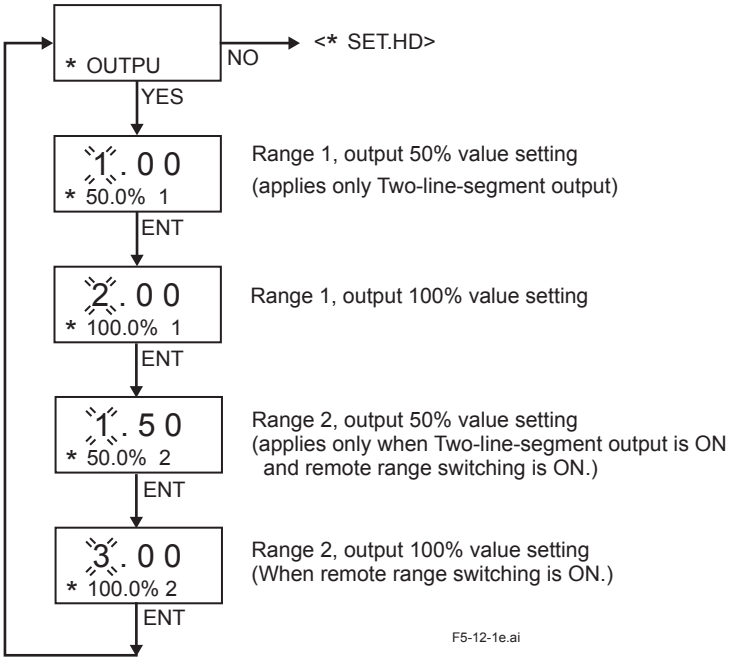

<Setting level>
Set output range?
MEASURE
OUTPUT
HOLD
(In hold status)
For the description of <* OUTPU>, see item (a) in 5.4.2.
Set hold parameter?
SETHOLD
For the description of <* SET.HD>, see item (b) in 5.4.2.
Enter the washing mode?
WASH
(Note 1)
For the description of <* WASH>, see item (c) in 5.4.2.
Enter the plateau mode?
PLATEAU
For the description of <* PLAT>, see item (d) in 5.4.2.
Enter the servise level?
SERVICE
ENT
To Ⓒ
<Service level>
Enter service code No.
SERVICE
Specify a setting item code number.
01 ENT
For the description of code 01, see item (f) in 5.4.2.
02 ENT
For the description of code 02, see item (f) in 5.4.2.
04 ENT
For the description of code 04, see item (f) in 5.4.2.
05 ENT
For the description of code 05, see item (f) in 5.4.2.
07 ENT
For the description of code 07, see item (f) in 5.4.2.
08 ENT
For the description of code 08, see item (f) in 5.4.2.
09 ENT
For the description of code 09, see item (f) in 5.4.2.
10 ENT
For the description of code 10, see item (f) in 5.4.2.
F5.4.2-1.ai

Note 1:
[*WASH] may be displayed as [*AZ.CAL] depending on setting. (Corresponds to mode (code) in Sec.4.2.3 Service Mode.
09 [*WA/CA] : Washing / Auto zero Calibration selection.)

Note : If any code other than code 01 ,02, 04, 05, 07, 08 and 10 (for example, code 80) is inadvertently entered, immediately press the (MODE) key to exit from the service level.

(a) <*OUTPU> (Output range setting mode)

Press the ✳ key to enter setting level and ∧ , ENT to select <*OUTPU>.
Set concentration value corresponding to each output span.Set span to at least 1.00 mg/L (or ppm).
When service code 05 “Two-line-segment output” is set “ON” then set 50% and 100% outputs. Default for this parameter is “OFF” .

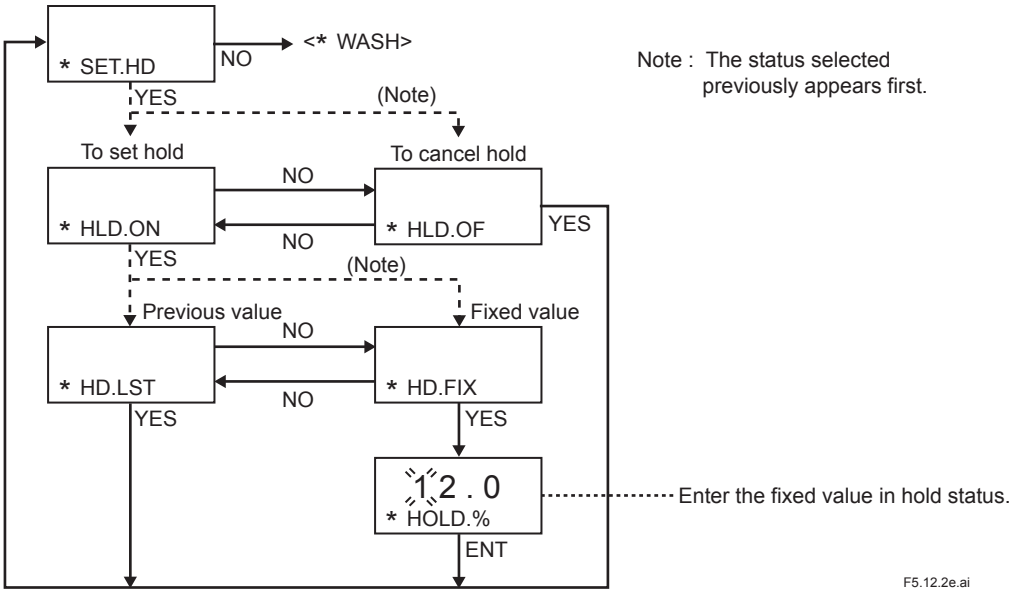


(b) <*SET.HD> (Hold Parameter Setting Mode)

Press the ✳ key to enter the setting level and press the NO key to select < *SET.HD >.
Pressing the YES key with “*HLD.ON” displayed causes the FC400G to enter calibration, setting level, and service level, automatically holding output. Pressing the YES key with “*HLD.OF” displayed cancels holding of output.

When “*HLD.ON” is selected, select the value immediately preceding hold (press YES key with “*HD.LST” displayed) or fixed value (press YES key with “*HD.FIX” displayed and make setting with “*HOLD.%” displayed) as a hold output value.

To cancel hold, use the hold ON / OFF mode in the operation level.



(c) <*WASH> (Wash mode)

The standard free available chlorine analyzer (non-reagent type) has no washing function; this mode is not used. Use this mode only when the washing function is provided for special specifications. Therefore, “*T.OFF” status must be generally set.

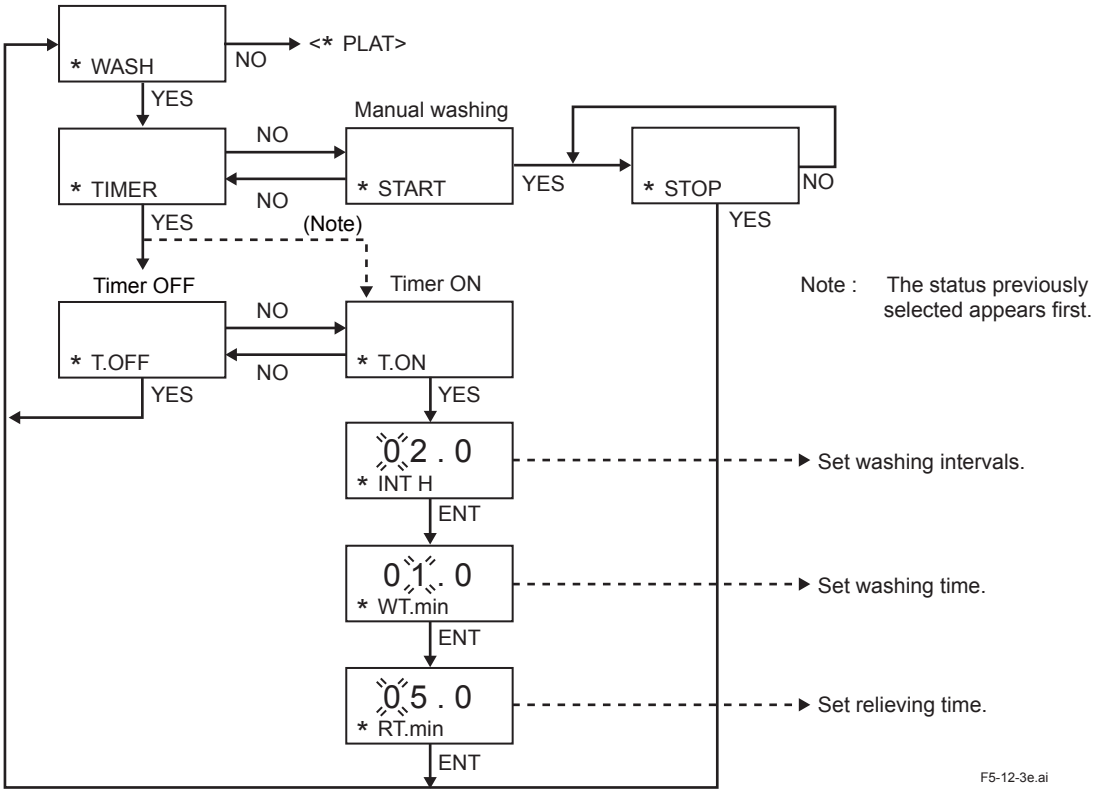
In case of special product with washing function, perform the operation with the followings.

Press the ✳ key to enter the setting level and press the NO key to select <*WASH >.

Press the YES key, *TIMER or *START displayed.

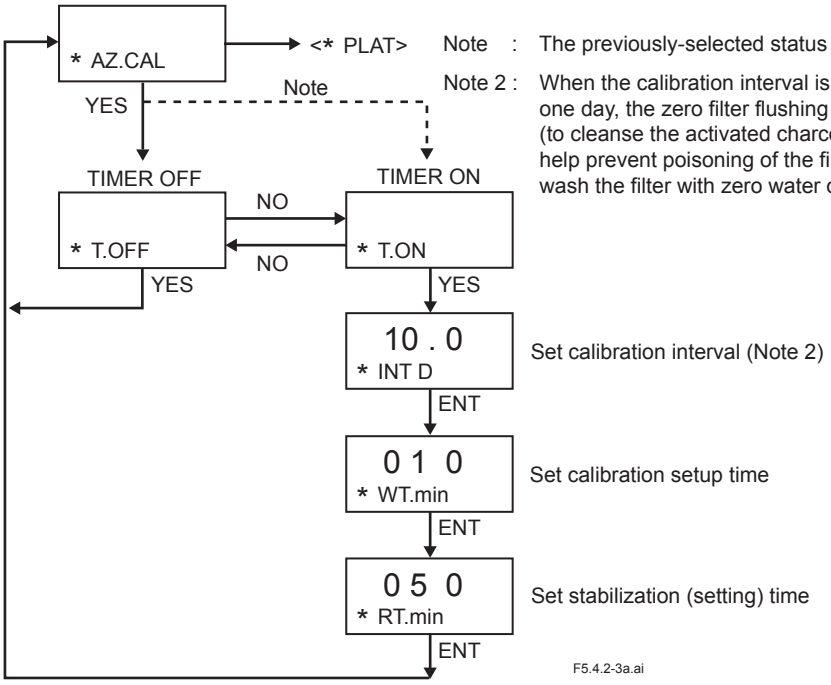
For auto-wash, press the YES key at the *TIMER display. *T.OFF and *T.ON options are displayed, select *T.ON to start auto wash, For the standard model without auto wash option, or to turn auto wash off, select *T.OFF.

For the timer function, set washing intervals *INT H (unit: hr.), washing time *WT.min (unit: min), and relieving time *RT.min (unit: min).
Manual washing starts by pressing NO key with TIMER displayed and then YES key with *START displayed. To stop manual washing, press YES key with *STOP displayed.



(d) <*AZ.CAL> (Auto Zero Calibration mode)

The activated charcoal filter is used and auto calibration is performed. To turn this function ON, service code 09 [Wash / Auto Calibration] switch is set to “1”. The default setting is “0” for Wash. For Auto Zero Calibration mode, the calibration interval “*INT D” (unit: days), calibration setup time “*WT.min” (unit: minutes), and stabilization (settling) time “*RT.min” . (unit: minutes) are set. The optimum time settings depend on the sample and the measurement environment.



Note : The previously-selected status is displayed.

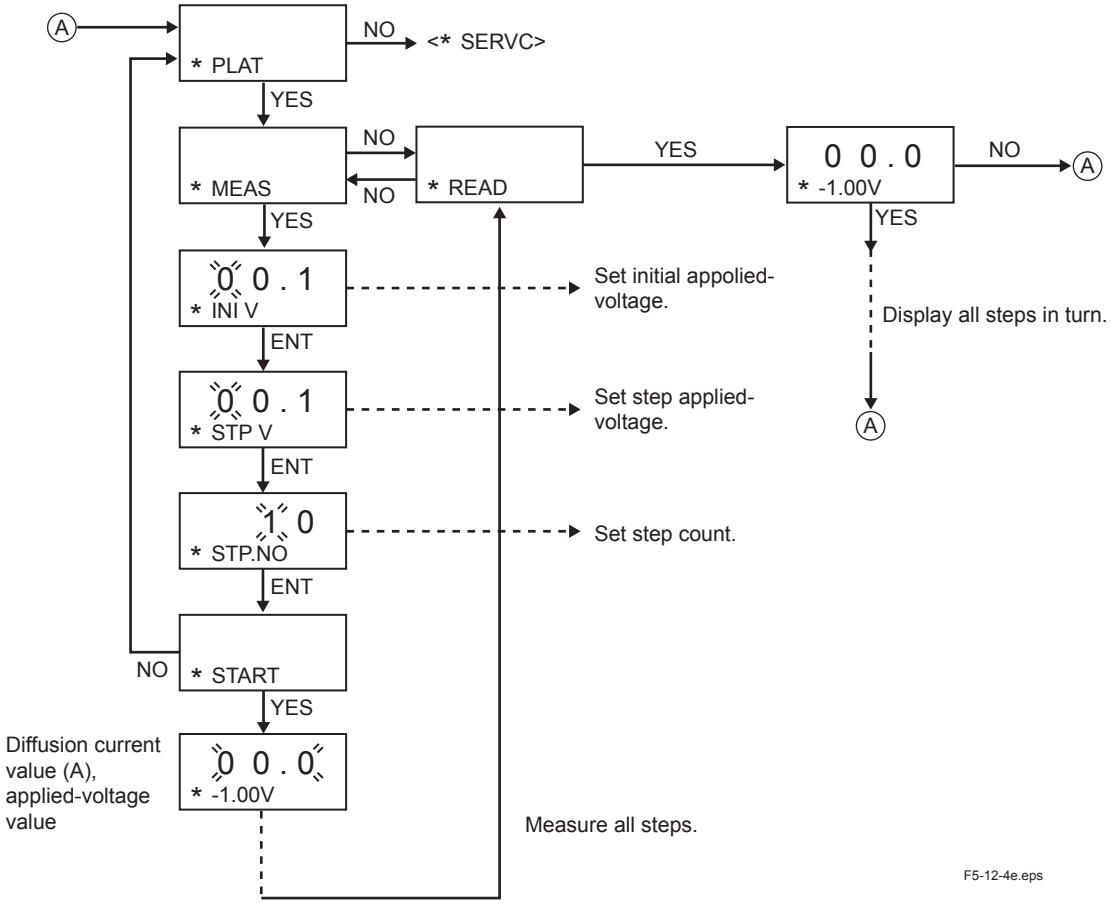
Note 2 : When the calibration interval is more than one day, the zero filter flushing functions (to cleanse the activated charcoal filter and help prevent poisoning of the filter) automatically wash the filter with zero water once a day.

(e) <*PLAT> (Plateau Mode)

Press the ✳ key to enter the setting level and press the NO key to select < *PLAT >.
Press the YES key with *MEAS displayed. When the plateau characteristic collection performs, enter YES key again.

In the plateau characteristic collection function (“ *MEAS”), setting initial applied voltage, step applied-voltage and step count and then selecting “*START” causes mg/l (or ppm) indication to blink, displaying the applied voltage. When the diffusion current value stabilizes, the applied voltage and diffusion current values are stored in the memory to apply the next step voltage. A step not needed can be aborted using the ENT key. This erases data in that step (“---” appears when such data is read), and the operation moves to the next step.

When the voltage has been applied to all steps, “*READ” appears. The data readout function (“*READ”) displays in turn the data acquired previously each time the YES key is pressed.



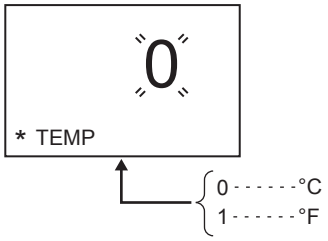
(f) <*SERVC> (Service Level)

Enter the YES key at *SERVC displayed, *CODE appears and enter the service level.

Enter codes 01 ,02, 04, 05, 07, 08 and 10 needed for setting various parameters in the service level.

Note: Never attempt to enter a code other than codes 01 , 02, 04, 05, 07, 08 and 10. If inadvertent entry is made, immediately press the MODE key. Entry of any code other than 01 , 02, 04, 05, 07, 08 and 10 may disable normal FC400G operation

● 01 * TEMP



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● 02 * FAIL

0 - - - - - - Temperature compensation range exceeded fail OFF
1 - - - - - - Temperature compensation range exceeded fail ON

Initial setting may apply.
(This causes effect whether it is set to either 0 or 1.)

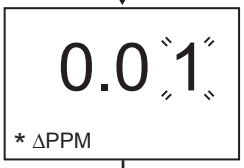
● 03 * BURN (Not used, do not change the setting.)

F5-12-5e.ai

● 04 * ΔT.SEC

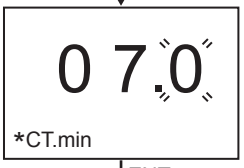
Setting of determination parameter *ΔT.SEC for calibration

ENT



Setting of determination parameter *ΔPPM for calibration

ENT



Setting of determination parameter *CT.min for calibration

Note : These parameters are also used in checking stability during plateau measurement.

ENT

<* SERVC>

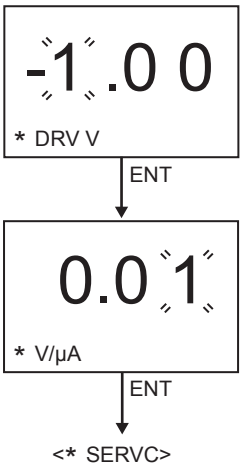
● 05 * NONLN

0 - - - - - - Linear output
1 - - - - - - Two-line-segment output

F5-12-6e.eps

● 06 Reserved Code (currently not used)

● 07 * DRV V



Set applied-voltage compensation parameter Start.

Set applied-voltage compensation parameter Slope.

Note : Applied voltage is controlled based on the following equation.
(Applied voltage)=(Start)+(Slope)x(diffusion current value)

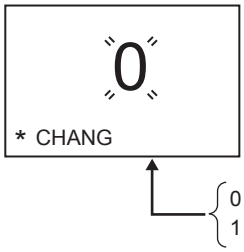
Procedure for Setting Applied-voltage Compensation to OFF (refer to 6.3.3 (5) Code 07: Setting Applied-voltage Compensation Parameters)

(1) Collect the plateau characteristic of the sample water (refer to 5.4.2 (e) <*PLAT> (Plateau Mode) and determine the applied-voltage value.

(2) Enter the value of (1) in Applied-voltage compensation parameter start and press the ENT key.

(3) Set Applied-voltage parameter compensation slope to 0.00V/μA and press the ENT key.

● 08 * CHANG



Note: "Electrode sensitivity initialization" is used at startup and for the calibration immediately after the replacement of the indicator electrode. Other than that, set "Normal use."
Please note that calibration for the electrode sensitivity initialization is performed unconditionally.*1
*1: Any value is written without determining whether or not it is a normal value.
If an incorrect calibration is performed, the measurement values after the calibration may be incorrect.

● 09 * WA/CA

● 10 * R.RNGE

F5-12-7e.eps

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6. OPERATION

6.1 Preparation for Operation

6.1.1 Inspecting Piping and Cable Installation Condition

Confirm that the piping and wiring to the FC400G free available chlorine analyzer have been correctly installed. For details of wiring, refer to Sec. 3.3.

6.1.2 Filling with Ceramic Beads for Electrode Polishing

Surface contamination of the indicator electrode results in measured value error. To avoid contamination-caused error, the electrode surface is continuously polished by ceramic beads during FC400G operation.

Ceramic beads are not filled into the bead case at factory shipment. Thus, pour the ceramic beads provided in the accessory box into the bead case as follows before starting the FC400G.

The combined chlorine insensitive version uses glass beads.

Before operation, ceramic beads are filled into the beads case of the detector.

[How to fill the ceramic beads]

Unscrew two fixing screws at the bottom of the electrode mechanism block (see Figure 6.3) to remove the measuring tank.

The ceramic beads are normally filled up to the bottommost notch of the beads case when the indicator electrode is inserted.

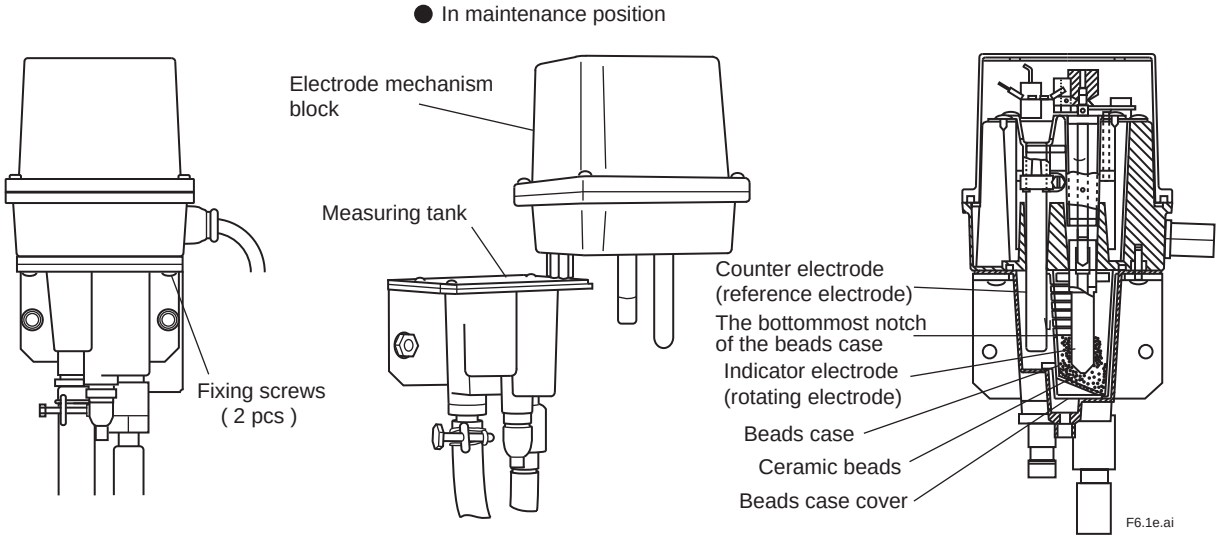


Figure 6.1 Measuring Tank Parts and Beads Case

6.1.3 Supplying Sample Water

Before starting to supply water to be measured, confirm that the needle valves in the FC400G and the sampling system are closed. When it's difficult to view the liquid surface in the measuring tank from outside, check the tank when it's time for electrode maintenance (refer to Figure 6.3).

(1) When there is no Sampling System
The sample supply pressure to the FC400G should be 1 to 150 kPa, and flow should be 0.1 to 2.5 l/min.
Next, slowly open the needle valve of the FC400G to adjust the water flow.

- The water should flow continuously along the whole length of the electrode , from the tip to where it enters the water (minimum flow 0.1 l/min.)
- Liquid flow should not be such that water splashes on the base of the electrode (maximum flow 2.5 l/ min.) Check that there is no leakage from the piping or from the breather hole of the tank.

(2) When the FC400G is used with ST401G Sampling System.
The sample supply pressure should be 100 to 750 kPa, and flow should be 0.1 to 10 l/min. Adjust flow using needle valve as described in (1) above.
(Note) Refer to the Instruction Manual IM12A0V2-E of the ST401G Sampling System.

6.1.4 Polishing the Indicator Electrode

The electrode surface of the indicator electrode must always be kept clean. Polish the electrode surface as follows:

(1) Press the MODE key on the converter to enter the operation level and press the YES NO key to select the <CELL> mode (cell motor ON / OFF). Press the NO key with respect to the message "CELL ON" displayed to stop the rotation of the indicator electrode.
When the electrode stops rotating, the CELL lamp extinguishes.

Remove the electrode mechanism block from the measuring tank and set up the block as shown in Figure 6.3. The electrode mechanism block is fixed to the measuring tank using two screws at the lower part of the mechanism block.

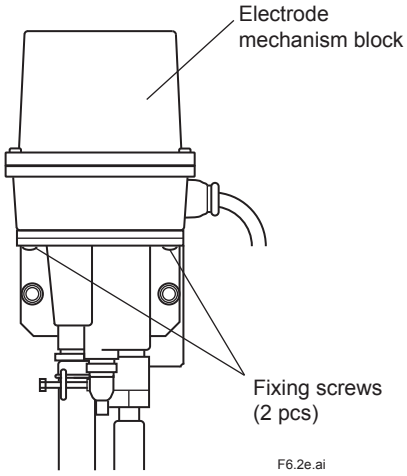


Figure 6.2 Electrode Mechanism Block Fixing Screws

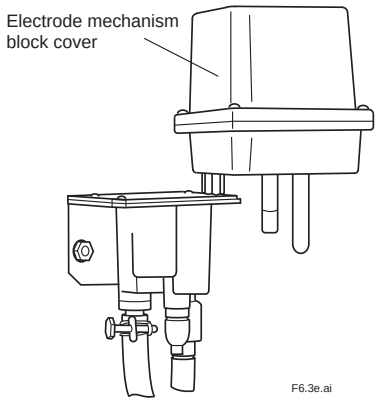


Figure 6.3 Under Maintenance

(2) Removing the Indicator Electrode
Remove the electrode mechanism block cover from the detector. Hold the gears so that the drive shaft does not turn and remove the indicator electrode. The electrode is screwed into the drive shaft; turn the electrode counterclockwise. In so doing, do not touch the brush. Also, exercise care so that you do not touch the electrode surface of the indicator electrode.

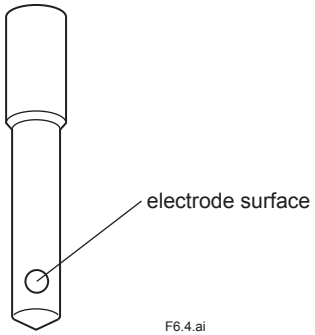


Figure 6.4 Appearance of the Indicator Electrode

(3) Polishing the Electrode Surface of the Indicator Electrode
Spread the provided abrasive (alumina) onto dampened gauze and thoroughly clean the electrode surface using such gauze so that any contamination such as oil and grease is completely removed. Then wash off any abrasives adhering to the electrode in clean running water.
After polishing and cleaning, confirm that contamination has been completely removed. The clean electrode surface must be uniformly wetted.

Note: Polish the electrode surface by following the instructions below when it has become corrugated or deformed from the original shape (about 3 mm in diameter). Polish the electrode surface with sandpaper (about #600) until the surface becomes finely rounded. Then, polish it with sandpaper (about #2000), and lastly with polishing powder (alumina). Make sure the electrode surface is clean and then install the indicator electrode. Reduce the amount of ceramic beads if the electrode has deformed greatly. The ceramic beads are normally filled up to the bottommost notch of the beads case when the indicator electrode is inserted.

(4) Installing the Indicator Electrode
Hold the gears so that the drive shaft does not turn, and sufficiently screw the electrode into the shaft. During installation, exercise care not to touch the electrode surface.

Note: Polish the electrode surface again if you have touched it.

(5) Attach the electrode mechanism cover. Then, set the electrode mechanism block to the measuring tank in place and fasten it using the fixing screws. Finally, use the <CELL> mode in the operation level to rotate the electrode.

6.1.5 Supplying Power

Before supplying power, check that the fuse holder cap in the converter is not loose.

A power switch in the power line to the FC400G is used to turn power ON / OFF (the FC400G does not have any internal power switch). Be careful not to turn on the power and cause an accident with the indicator electrode or belt used to rotate it when the cover is removed or the electrodes are parked in the maintenance position shown in Figure 6.3

(Note) When power is supplied, the instrument enters measurement mode.

6.1.6 Checking Electrode Mechanism Block

Check as follows that the electrode rotates normally. Put the electrode in the maintenance position (Figure 6.3) or lift the cover, and check the following:

- There should be only a slight sound from the belt or axles when the electrode rotates. There should not be any sound like items making contact or vibrating.
- There should be no unevenness or vibration.
- The drive belt should not be visibly loose, resulting in a loss of traction.

Replace the electrode mechanism block in the measuring tank after confirming that there are no problems.

After replacing the electrode mechanism block in the tank, attach the cover. Stop the rotation of the electrode. Switch the converter to <CELL> mode (display CELL. ON and press NO key to stop cell motor and thus electrode rotation.

Mount electrode mechanism block on measuring tank, and tighten fixing screws sufficiently. Then press YES in CELL mode to start electrode rotation. When the indicator electrode is rotating

(cell motor power is supplied from converter) then “CELL” is displayed on CONTACTS

display of converter panel.

6.1.7 Filling Zero Water, and Test Operation

For auto zero calibration to proceed smoothly, you need to flow zero water (chlorine-free water) through the zero filter case before starting, then attach zero filter and operate without turning on auto calibration.

After replacing the filter, or when the normal calibration interval has been exceeded, you needs to run the instrument in offline mode for a while to allow conditions to stabilize before turning on the Auto Zero Calibration functions.

- Close BV2 and open BV3 ball valve.
- Be careful that water does not leak from activated charcoal filter F1 or piping, and that there are no bubbles is pipeline.
- After 20 min. operation like this, confirm that residual chlorine reading is near zero. Set auto zero interval, warm up time, and settling time according to the environment.
- Close BV3 and BV2 ball valve.

6.1.8 Setting Operation Parameters

When the FC400G Free Available Chlorine Analyzer arrives at your site, it will operate based on the initial data set at the time of shipment.

Set the appropriate parameters to suit your operation conditions. Refer to Sec. 6.3 for the types and operations of setting parameters. Key operations for displaying the setting mode items and setting data are described in Chapter 5.

6.1.9 Calibration

Operate the FC400G for at least one hour under normal operating conditions before calibrating.

(Note) The electrode characteristics are not stable immediately after cleaning the electrode, this is the reason for leaving the instrument running for a while before calibrating it.

Refer to Chapter 7 for calibration requirements.

6.2 Normal Operation

6.2.1 Maintenance during Normal Operation

Perform calibration regularly at the specified calibration interval.

Promptly fix any abnormality (see Sec. 9.1). After initial startup, check how clean the indicator electrodes are one or two weeks before regular scheduled maintenance is due, to determine whether the scheduled maintenance interval should be shortened.

6.2.2 Shutting Down then Restarting Operation

The data in the FC400G is retained even when power is disconnected. If it is to be stopped for a long period, then power should be disconnected. If power will continue to be supplied, it's recommended that the cell motor be stopped. When restarting, perform a checkup and maintenance (see Chapter 8).

6.3 Requirements for Setting Operation Data

6.3.1 Setting Items

Table 6.1 shows different Operating and Setting items. Table 6.2 shows Setting items in Service level.

Table 6.1 Setting Item List (Set Values at Shipment and Their Setting Range) -1

	Setting Item	Initial Value (at Factory Shipment)	Selection and Setting Range
Opera -tion Level	<DISP> (Display) Mode		
	• Message area display content selection	Temperature display	Sample temperature, diffusion current, applied voltage, output %, slope, and zero point
Setting Level	<*OUTPU> (Output range setting) Mode		
	• Range 1		
	Setting corresponding to 50% output	1.00 [mg/L]	0.00 to 3.00 [mg/L]
	Setting corresponding to 100% output	2.00 [mg/L]	0.00 to 3.00 [mg/L]
	• Range 2		
	Setting corresponding to 50% output	1.00 [mg/L]	0.00 to 3.00 [mg/L]
	Setting corresponding to 100% output	2.00 [mg/L]	0.00 to 3.00 [mg/L]
	<*SET.HD> (Hold Parameter Setting) Mode		
	• Output hold ON / OFF selection	ON (*HLD. ON)	ON (*HLD. ON) OFF (*HLD. OF)
	• Hold output value selection	Value immediately preceding hold (*HD.LST)	Value immediately preceding hold (*HD. LST) Fixed value (*HD. FIX)
	• Setting of fixed value *HOLD.%	50.0 [%]	0.0 to 100.0 [%]
	<*WA / CA> (Wash / Auto-zero Calibration) Mode		
	<*WASH> (Washing) Mode		
	• Washing timer ON / OFF selection	Timer OFF (* T. OFF)	Timer ON (* T. ON) Timer OFF (* T. OFF)
	• Washing interval setting (*INT H)	2.0 [hr]	0.1 to 24.0 [hr]
	• Washing time setting (*WT.min)	1.0 [min]	0.1 to 25.0 [min]
	• Releasing time setting (*RT.min)	5.0 [min]	0.1 to 25.0 [min]
	<*AZ.CAL> (Auto-zero Calibration) Mode		
	• Calibration timer ON/OFF selection	Timer OFF (* T.OFF) (Note)	Timer ON / OFF
	• Calibration interval setting (*INT D)	10.0 (days)	0.1 to 99.9 (days)
	• Calibration setup time setting (*WT.min)	010 (min)	1 to 100 (min)
	• Stabilization (settling) time setting (*RT.min)	010 (min)	1 to 100 (min)
	<*PLAT> (Plateau Measurement) Mode		
	• Initial applied voltage setting (*INI V)	1.00 [V]	-1.00 to 1.00 [V]
	• Step applied-voltage setting (*STPV)	-0.20 [V]	-1.00 to 1.00 [V]
	• Step count setting (*STP.NO)	10 [steps]	1 to 20 [steps]

(Note) If you order the /AZC option, Timer ON (*T. ON) is the default.

Table 6.2 Setting Item List (Set Values at Shipment and Their Setting at Range)-2

	Setting Item	Initial Value (at Factory Shipment)	Selection and Setting Range
Service Level	Code 01 (*TEMP) Mode		
	•Temperature unit selection	°C (0)	°C (0), °F (1)
	Code 02 (*FAIL) Mode		
	•Reserved code	0	(0), (1) Successive operation is not affected whether (0) or (1) is selected.
	•Selection of temperature compensation range exceeding fail contact output ON / OFF	OFF (0)	OFF (0), ON (1)
	Code 04 (*ΔT.SEC) Mode		
	•Setting of stability determination parameter *ΔT.SEC	10 [sec]	5 to 200 [sec]
	•Setting of stability determination parameter *ΔPPM	0.01 [mg/l]	0.01 to 0.05 [mg/l]
	•Setting of stability determination parameter *CT.min	7.0 [min]	0.1 to 25.0 [min]
	Code 05 (*NONLN) Mode		
	•Selection of linear output / two - line- segment output	Liner output (0)	Linear output (0), Two-line-segment output (1)
	Code 07 (*DRV V) Mode		
	•Setting of applied voltage compensation parameter Start, *DRV V	-0.10 [V] (Note 1)	-1.50 to 1.50 [V]
	•Setting of applied voltage compensation parameter Slope, *V / μA	-0.02 [V/μA] (Note 2)	-0.10 to 0.00 [V/μA]
	Code 08 (*CHANG) Mode		
	•Selection of electrode sensitivity initialization ON /OFF	OFF (0)	OFF (0), ON (1)
	Code 09 (*WA / CA) Mode		
	*Wash-Auto Zero Calibration	Wash (0) (Note 3)	Wash (0), Auto Zero Calibration (1)
	Code 10 (*R.RNGE) Mode		
	*Remote Range switching ON / OFF selection	OFF (0) (Note 4)	OFF (0), ON (1)

(Note 1) Set to + 0.1V in (to decrease influence of) combined chlorine insensitive version
(Note 2) Set to -0.01V/μA in (to decrease influence of) combined chlorine insensitive version
(Note 3) When ST401G/AZC is specified, initial value is Auto Zero Calibration (1).
(Note 4) When ST401G/RR is specified, initial value is ON (1).

6.3.2 Setting in the Setting Level

Unscrew four screws in the front panel of the FC400G converter to remove the converter case cover. Then press the (✳) key to select the setting level.

(a) Output range setting (<*OUTPU> Mode)
When straight-line output is selected using SERVICE code 05, you need to set only the concentration value corresponding to output of 100% . The setting range is 0.00 to 3.00 mg/L, but the span should be set to at least 1.00 mg/L.
When remote range switching is turned ON using SERVICE code 10, then set the concentration values corresponding to outputs of 100% for both ranges 1 and 2.
When two-line-segment output is selected using SERVICE code 05, and remote range switching is also turned ON using SERVICE code 10, then set the concentration values corresponding to outputs of 50% and 100% for both ranges 1 and 2. Shipping-time default settings are:
Range1 50% : 1.00 mg/L, 100% : 2.00 mg/L
Range2 50% : 1.50 mg/L, 100% : 3.00 mg/L

(b) Hold Parameters Setting (<*SET.HD> Mode)
Set various data for hold of output during maintenance.

- Output Hold ON/OFF Selection
  Select *HLD.OF to disable output hold or *HLD.ON to enable output hold during maintenance.

- Selecting *HLD.ON causes output to be automatically held during calibration of zero point and / or span, automatic washing, and entry into the setting level by pressing the (✳) key.
  Further, output hold can be manually made in the <HOLD> mode in the operation level. When the FC400G is in hold status, appears on the LCD.
  Note: Selection of *HLD.OF in the setting level disables entry into the <HOLD> mode in the operation level.

- Hold Output Value Selection (when *HLD.ON is selected)
  Select *HD .LST to set the value immediately preceding hold as hold output value or *HD.FIX to set a fixed output value (preset value).

- Setting the fixed Output Value (when *HD.FIX is selected)
  Set fixed output value in the range of 0.0 to 100.0%. At factory shipment, the fixed output value is set to 50.0%.

(c) Wash / Auto zero calibration parameter setting (<*WASH>,<*AZ.CAL> Mode)
Wash parameter setting <*WASH> Mode
This mode is not generally used since the standard free available chlorine analyzer has no washing function. Use this mode only if the washing function is added to the FC400G for special specifications. Therefore, *T. OFF must generally be established.
Setting for Special Specification of the FC400G is as follows.

- Washing Parameter Setting / Manual Washing Selection
  To set up various parameters for washing timer, select *TIMER. For manual Washing, select *START .
  Press the (YES) key. This starts washing and message display becomes “STOP”. To stop washing, re-press the (YES) key.

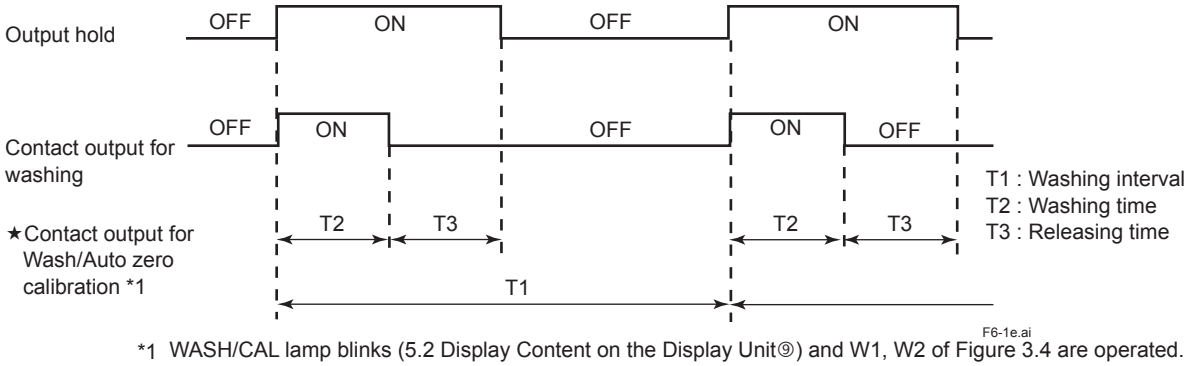
- Washing Timer ON/ OFF Selection
  If the washing timer is not used (for the standard free available chlorine analyzer), always select *T. OFF. Select *T. ON only when the washing timer is used.

- Washing Interval Setting (when *T. ON is selected)
  Set washing interval *INT H in the range of 0.1 to 24.0 hrs. The washing interval is set to 2.0 hrs at factory shipment.

• Washing Time Setting (when *T. ON is selected)
Set washing time *WT.min in the range of 0.1 to 25.0 min. The washing time is set to 1.0 min at factory shipment.

• Releasing Time Setting (when *T. ON is selected)
Set releasing time *RT.min (time required for eliminating the effects of washing solution) in the range of 0.1 to 25.0 min. The releasing time is set to 5.0 min at factory shipment.

Note: Contact output status during washing is as shown below



*1 WASH/CAL lamp blinks (5.2 Display Content on the Display Unit⑨) and W1, W2 of Figure 3.4 are operated.

Auto zero calibration (<*AZ. CAL > Mode) (refer to Sec. 7.2.3)

• Auto zero calibration timer ON /OFF setting
Select *T.OFF if you don't want to use this timer, otherwise select *T. ON.

• Auto zero calibration interval setting (effective when *T. ON)
Set Auto zero calibration interval using *INT D to between 0.1 and 99.9 days.
10.0 is the shipping-time default setting.

• Calibration setup time setting (effective when *T. ON)
Set Calibration setup time using *WT.min to between 1 and 100 minutes.
10 is the shipping-time default setting.

• Stabilization (settling) setup time setting (effective when *T. ON)
Set Stabilization (settling) setup time using *RT.min to between 1 and 100 minutes.
10 is the shipping-time default setting.
Optimum values for these time settings depend on sample and measurement environment.

When setting auto zero calibration parameters, zero filter flushing function will be activated by supplying zero water once in 24 hours to protect the corrosive of the activated charcoal filter. The measured value is held, HOLD lights, and "FLUSH" (blinking) is displayed.
(1) Auto zero calibration is selected,
(2) Auto zero calibration timer is turned ON,
(3) Auto zero calibration interval needs to be one day (24 hours) or longer. (refer to Sec. 7.2.2)

(d) Plateau Measurement (<* PLAT> Mode)
Set the initial applied voltage, Step applied-voltage, and step count, then give a running command. This causes the voltage corresponding to the setting parameters to be applied in turn, allowing collection of the plateau characteristic (voltage to current characteristic). The plateau characteristic obtained can be used as guidance for determining electrode abnormality or the degree of deterioration.

Note: The applied voltage changes during acquisition of the plateau characteristic. Therefore, when output hold has been canceled (pressing the YES key with *HLD.OF displayed for <*SET.HD> in item (2), Sec. 5.4.2), output changes in accordance with the set output range.
Utilizing this feature, changes in the free chlorine concentration value can be replaced by the status of current change to be output, for example, to a recorder. The output range must be set to an appropriate level in accordance with the plateau characteristics.
(Output of all changes may not be available depending on the applied voltage setting range.)

Figure 6.5 shows the relationship between the initial applied voltage, step applied voltage, and step count.

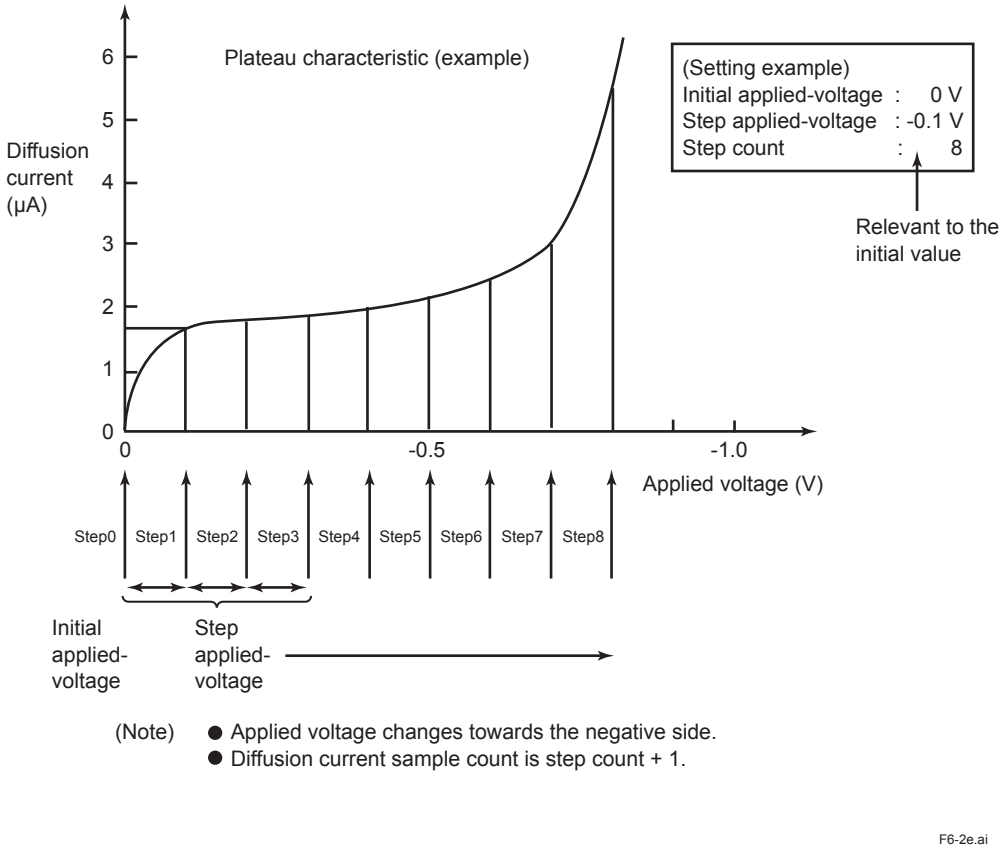


Figure 6.5 Example of Plateau Characteristic Collection

- Selection of plateau characteristic collection/data readout
  To collect plateau characteristic data, select message *MEAS and press the YES key. Pressing the NO key with *MEAS displayed causes the FC400G to enter *READ. Pressing the YES key again calls up the previously collected data in turn.
- Setting Initial Applied-voltage (when *MEAS is selected)
  Set initial applied-voltage *INI V in the range of -1.00 to 1.00 V. This parameter is set to 1.00 V at factory shipment.
- Setting Step Applied-voltage (when *MEAS is selected)
  Set step applied-voltage *STP V in the range of -1.00 to 1.00 V. This parameter is set to -0.20 V at factory shipment.
- Setting Step count (when *MEAS is selected)
  Set step count *STP NO in the range of 1 to 20 steps. This parameter is set to step 10 at factory shipment.
  After completion of setting of the noted parameters, *START appears on the LCD.
  Then, press the YES key. This starts plateau characteristic collection.

6.3.3 Setting in the Service Level

Press the YES key to enter the service level on *SERVC display in Setting Level.

Enter a code in the service level to enter the service mode.

(1) Code 01: Selecting Temperature Unit (°C / °F) (*TEMP Mode)
Set temperature unit to “0” to apply °C or “1” to use °F.
This parameter is set to “0” (°C) at factory shipment.

(2) Code 02: Selecting Exceeded Temperature Compensation Range Check ON / OFF (*FAIL Mode)

Note : The left digit of two-digit figures is the reserved code. This does not affect operation whether it is 0 or 1.

To check if sample water temperature is in the temperature compensation range (0 to 40°C), set the right digit of the figures to “ 1 ”. Set it to “ 0 ” when not conducting a check.
When this parameter is set to “ 1 ” (conducting the check), fail contact output becomes ON if sample water temperature exceeds the temperature compensation range.
This parameter is set to “ 0 ” (no check) at factory shipment.

(3) Code 04: Setting Stability Determination Parameters (*ΔT.SEC Mode)
Set parameters (ΔPPM / ΔT and CT) used to determine if electrode operation is stable during zero point and / or span calibration.
If concentration changes by ΔPPM mg/l or more during ΔT seconds even when the time elapses for CT minutes, meaning that operation is unstable, error indication is generated,

- Setting *ΔT.SEC (Stability Check Time)
  Set the stability check time (*ΔT.SEC) in the range of 5 to 200 sec. This parameter is set to 10 sec at factory shipment.

- Setting *ΔPPM (Concentration Change Allowance)
  Set the concentration change allowance (*ΔPPM) in the range of 0.01 to 0.05 mg/l. This parameter is set to 0.01 mg/l at factory shipment.

- Setting *CT. min (Stabilization Wait Time)
  Set stabilization wait time (*CT.min) in the range of 0.1 to 25.0 min. This parameter is set to 7.0 min at factory shipment.

(4) Code 05: Selecting Linear Output / Two-line-segment Output (*NONLN Mode)
Set the parameter to “0” to generate linear output (see Figure 6.6) in the range of 0 to 100% or to “ 1 ” to generate two-line-segment output where output is segmented into two steps; 0 to 50% and 50 to 100%. This parameter is set to “0” (linear output) at factory shipment.

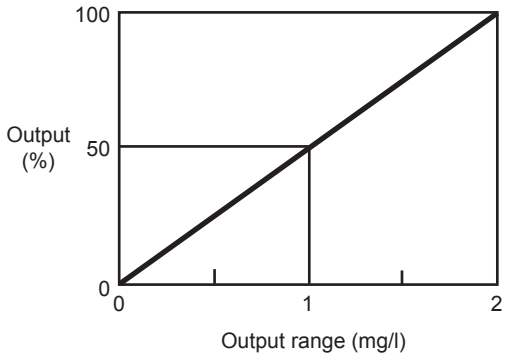


Figure 6.6 Linear Output Example

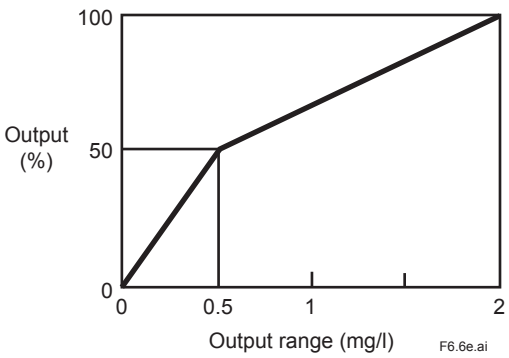


Figure 6.7 Two-Line-Segment Output Example

(5) Code 07: Setting Applied-voltage Compensation Parameters (*DRV V Mode)
In the free available chlorine analyzer, optimum applied-voltage value changes in proportion to the diffusion current value as shown in the plateau characteristic in Figure 6.8.
This requires applied-voltage compensation be made as expressed by the following equation.
(Applied voltage) = (DRV V) + (V/ µA) x (diffusion current value)

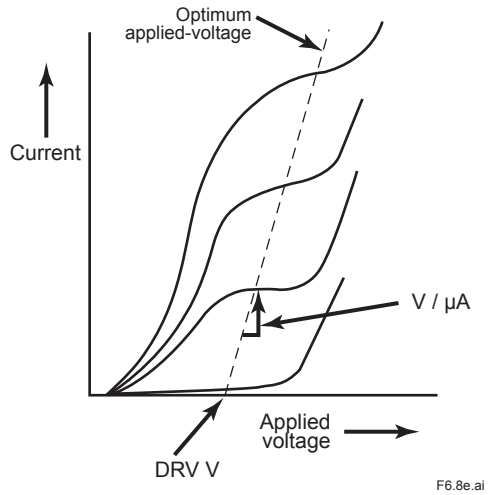


Figure 6.8 Plateau Characteristic of the Free Available Chlorine Analyzer

• Setting *DRV V (Start Applied-voltage Value)
Set start applied-voltage value (*DRV V) in the range of -1.50 to 1.50 V. This parameter is set to -0.10 V at factory shipment.
Set to +0.1 V in (to decrease influence of) combined chlorine insensitive version (option).

• Setting *V/µA (Slope Value)
Set the slope value, or applied voltage change(V/µA) per 1 µA , in the range of - 0.10 to 0.00 V/µA. This parameter is set to -0.02 V/µA at factory shipment. Set to -0.01V/µA in (to decrease influence of) combined chlorine insensitive version (option).

(6) Code 08: Selecting Electrode Sensitivity Initialization ON / OFF (*CHANG Mode)
Set this parameter to " 1 " only if you wish to rewrite the slope (" SL ") displayed in the message area selectable in the operation level <DISP> mode, to 1.00 (e.g., for electrode replacement). Generally set this parameter to " 0 ". This allows the sensitivity relative to the sensitivity reached when the parameter is rewritten to 1.00, to be checked using " SL ".
This parameter is set to " 0 " (initialization OFF) at factory shipment.

(7) Code 09: Washing / Auto zero calibration selection (*WA / CA Mode)
Selects either washing or auto zero calibration
For washing, select " 0 ", and for auto zero calibration, select " 1 ". Shipping-time default is " 0 ".

(8) Code 10: Remote range switching ON / OFF (*R.RNGE Mode)
When input exceeds a preset voltage, the range is switched (Range can be changed).
Set " 1 " (ON) to enable remote range switching. Shipping-time default is " 0 " OFF, disabled.

7. CALIBRATION

Calibration is required to correctly measure free chlorine concentrations using the FC400G. Calibration is performed for the zero point and span. There are two methods to calibrate the zero point: open input circuit and chlorine-free-water-based measurement methods. Also, there are two span calibration methods: sampling and standard solution methods. Calibration is performed at start-up or when operation is restarted after being stopped for a long period of time.

Also, calibration is performed periodically (recommended every month or so) during operation. This chapter describes the calibration procedure.

7.1 Running-in

In general, calibration requires running-in. Always run in the FC400G at start-up or when it restarts after being temporarily stopped.

Running-in requires, first, polishing of the indicator electrode. Comply with Sec. 6.1.4 on how to polish the indicator electrode.

After polishing, install the polished indicator electrode and select “CELL. ON” in the <CELL> mode. Then press the (YES) key to rotate the electrode. Operate the free available chlorine analyzer for approx. one hour.

Calibration can be conducted after this approx. 1 hr running-in.

Note: It is recommended that electrode polishing be performed even when calibration is performed periodically during operation. However, electrode polishing can be omitted if the calibration interval is short and it can be determined that the electrode is not contaminated.
The characteristic readings of the indicator electrode are temporarily not stable immediately after polishing the electrode. Therefore, after electrode polishing is performed, leave the FC400G running for a while (approx. 1 hour) under the measurement conditions until the characteristic readings of the indicator electrode stabilize. Calibration is performed following this running-in.

7.2 Zero Calibration

The method of calibrating the zero point of the free available chlorine analyzer includes two approaches; open input circuit and chlorine-free-water-based measurement methods.

In the former the electrode is exposed in the air so that no current flows between the indicator electrode (rotating electrode) and counter electrode. The latter uses chlorine-free water (e.g., water filtered through activated charcoal).

During auto zero calibration with the activated charcoal filter, chlorine-free (chlorine not included) water must be used.

If the FC400G generally measures free chlorine concentrations as low as 0.1 mg/l, conduct zero calibration using the chlorine-free-water-based measuring method.

However, the open input circuit method, easy to conduct, is generally used.

7.2.1 Method of Zero Calibration using Open Input Circuit Method

This section describes zero calibration using open input circuit method.

Note: This section also explains how to stop the indicator electrode when electrode mechanism block is moved. It is not necessary to stop the indicator electrode for the purpose of calibration, but rather _ before lifting out the electrode mechanism block or moving the unit _ to eliminate the chance of the electrode hitting something while rotating.

(1) Before lifting the electrode mechanism block from the measuring tank, stop the electrode rotation. In <CELL> mode of Operation Level (“CELL.ON” displayed in message display), press the NO key. Stopping the electrode rotation (turning drive motor power OFF) results in the “CELL” display disappearing.

(2) Place the electrode in its maintenance position (see Figure 7.1) and start it rotating again.
Loosen the two screws that fix the electrode mechanism block to the measuring tank, and lift it vertically to remove it from the tank. After resting the block in its maintenance position, pressing the YES key in <CELL> mode restarts electrode rotation, and the “CELL” display is lit.

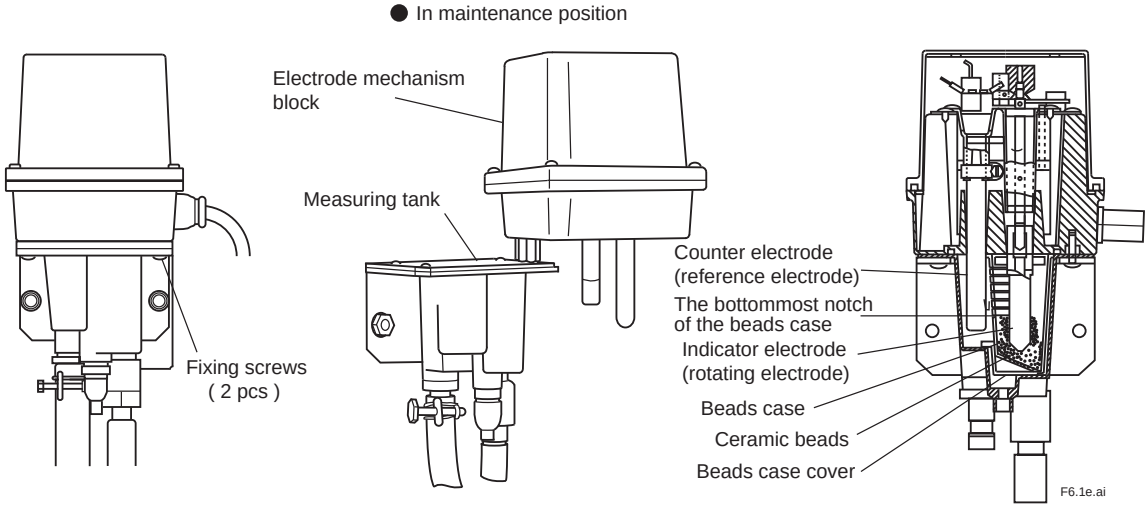


Figure 7.1 Electrode Mechanism Block in maintenance

(3) Select <CAL> mode (“ZERO” displayed on message display)

Note: If Service Level code 08 is set to “1” for “initialize electrode sensitivity”, then placing the unit in <CAL> mode results in “NO.CHNG” or “CHANGE” being displayed. In response (see Sec. 7.3) press the YES key and “ZERO” is displayed.

(4) Perform zero calibration
Check that the data displayed on the data display has stabilized, then press the YES key. While calibration is being performed, a blinking “mg/l” or “ppm” is displayed. When calibration ends normally, “ZR.END” is displayed.

Note: During calibration, if an abnormality occurs then “END.E6” or “END.E7” are displayed. Refer to Sec. 7.4 for a description of how to fix the problem.

(5) Exiting zero calibration
Confirm that a normal “ZR.END” rather than an error message then press the YES key. Pressing the YES key switches the display to “SPAN”. After stopping the indicator electrode, revert the electrode to its position in the measuring tank. After fixing the electrode mechanism block to the measuring tank, restart electrode rotation. Perform span calibration (see Sec. 7.3) after performing zero calibration.

7.2.2 Method of Zero Calibration using Chlorine-free Water

The method of performing Zero Calibration using Chlorine-free Water is as follows:

Note that the electrode mechanism block should be secured to the measuring tank, and the electrodes rotating.

(1) Prepare 2-3 liters of chlorine-free water.
The chlorine-free water should consist of pure water to which 10 ml of pH 7 buffer solution and 50 mg of NaCl has been added.

(2) Select <CAL> mode (“ZERO” displayed in message display.)

Note: If Service Level code 08 is set to “1” for “initialize electrode sensitivity”, then placing the unit in <CAL> mode results in “NO.CHNG” or “CHANGE” being displayed. In response (see Sec. 7.3) press the YES key and “ZERO” is displayed.

(3) Connect piping to supply chlorine-free water to the FC400G.
Close the needle valve at the sample water inlet of the FC400G, and remove the sample water piping from the joint to the measuring tank. Release any sample water remaining in the measuring tank by opening the drain cock on the tank. Use tubing and hardware to connect the chlorine-free water tank to the sample water inlet. Use a head difference or a pump to supply chlorine-free water at a flow rate of at least 100 ml/min.

(4) With the chlorine-free water flowing at the specified flow rate, watch the data display and wait for it to stabilize.

(5) Perform zero calibration
Check that the data displayed on the data display has stabilized, then press the YES key.
While calibration is being performed, a blinking “mg/l” or “ppm” is displayed. When calibration ends normally, “ZR.END” is displayed.

Note: During calibration, if an abnormality occurs then “END.E6” or “END.E7” are displayed. Refer to Sec. 7.4 for a description of how to fix the problem.

(6) Exiting Zero calibration
Confirm that a normal “ZR.END” rather than an error message then press the YES key.
Pressing the YES key switches the display to “SPAN”. After stopping the indicator electrode, revert the electrode to its position in the measuring tank. After fixing the electrode mechanism block to the measuring tank, restart electrode rotation. Perform span calibration (see Sec. 7.3) after performing zero calibration.

7.2.3 Auto Zero Calibration using Chlorine-free (chlorine not included) Water.

Auto Zero Calibration is performed using an activated charcoal filter. Setup as follows:

(1) In Service Level code 09 [Washing / Auto zero calibration] set “1” for Auto zero calibration.
The default is “0” for washing.

(2) Select “*AZ.CAL” for Auto zero calibration sequence in Setting Level.
After selecting “Auto Zero Calibration timer ON (*T. ON), select Calibration Interval (*INT D), Calibration Setup time (WT.min), and Stabilization (settling) time (*RT.min).
Default values are : For Calibration Interval (*INT D), 10 days (refer to zero filter flushing functions); for Calibration Setup time (WT. min), 10 min ., for Stabilization (settling) time (*RT. min), 10 min.

When Auto Zero Calibration starts, the analog output is held, <HOLD> lights, and <CAL> (blinking) is displayed. At the same time, the <MAINT> contact output turns ON.

After the calibration setup time has elapsed, the measured value drops to near zero, and after this measured value has stabilized it is automatically reset to zero. The method used to determine if the value has stabilized is the same as for manual calibration.

When calibration is completed, the flow through the unit is switched from zero water (pure deionized water) to sample water, then after the stabilization (settling) time has elapsed the analog output hold is released, <HOLD> and <CAL> go OFF, and the <MAINT> contact turns OFF.

NOTE

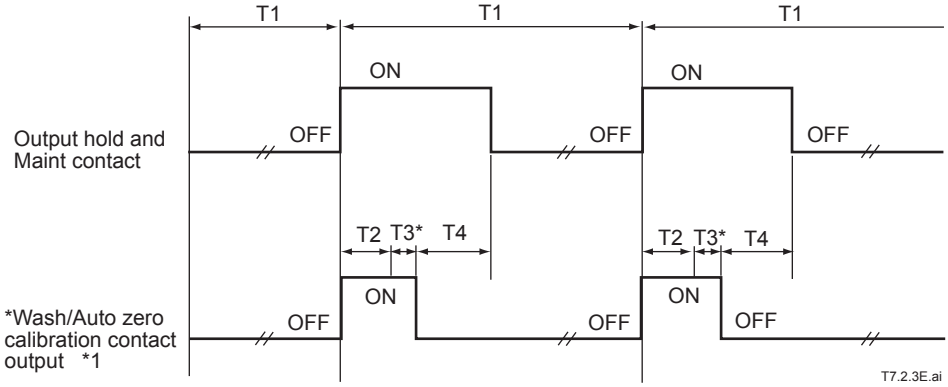
(1) During Auto calibration, if the MODE key or ✳ key are pressed then Auto calibration is aborted, and immediately the analog output hold is released, <HOLD> and <CAL> go OFF, and the <MAINT> contact output goes OFF. The calibration interval timer is reset to zero.

(2) When the following conditions are true, the calibration interval timer starts to count from 0 to its "count up" setting.

- When the unit was started up with Auto zero calibration turned ON.
- When Auto zero calibration is turned ON.
- After the Auto zero calibration interval is changed (provided Auto zero calibration is turned ON).
- When the Wash / Auto zero calibration setting is switched to Auto zero calibration.

(3) The counter timer keeps running regardless of operation mode.

(4) Auto zero calibration is initiated only in MEAS mode. If the counter reaches its "count up" setting while the instrument is in MAINT mode, calibration is cancelled - not triggered - that time : the timer is reset and counting restarts.



T1 : Auto zero calibration interval

T2 : Auto zero calibration setup time

T3 : Auto zero calibration time : varies depending on conditions of sets stability determination parameter.

T4 : Auto zero stabilization (settling) time

*1 WASH/CAL lamp blinks (5.2 Display Content on the Display Unit⑨) and W1, W2 of Figure 3.4 are operated.

● Zero filter flushing

Under the following condition, zero filter flushing function will be activated automatically.

1) Wash / Auto zero calibration set to Auto zero calibration,
2) Auto zero calibration timer turned ON, and
3) Auto zero calibration interval set to one day or longer.

● Zero filter flushing interval and sequence

Interval is fixed, once in 24 hours.

When flushing starts, analog output is held, <HOLD> lights, <FLUSH> flashes, and the <MAINT> contact turns ON. During Auto zero calibration setup time, "zero" water flows then - after the stabilization (settling) time - it reverts to sample water.

Finally analog output hold, <HOLD> display, and <FLUSH> display revert to normal, and <MAINT> contact output turns OFF.

Zero filter flushing interval timer is started and stopped as follows:
Timer is started when:

- Power is ON and zero filter flushing start conditions are satisfied.
- Auto zero calibration interval is at least one day and Auto calibration functions are ON.
- When Auto calibration functions are ON and Auto zero calibration interval is changed to at least one day.
- When Auto zero calibration is ON and Auto zero calibration interval is at least one day, and “Wash / Auto zero calibration setting” is switched to Auto zero calibration.

When timer (are) starts, counter is reset.

Counter is stopped when:

- Zero filter flushing timer is ON and Auto calibration setting is turned OFF.
- Zero filter flushing timer is ON and Auto zero calibration interval is reduced to less than one day.
- Zero filter flushing timer is ON and Wash / Auto zero calibration setting is changed to Wash.

NOTE

1) During zero filter flushing, if Auto zero calibration is started then zero filter flushing is aborted.
2) If the “zero filter flushing counter” reaches its “count up” setting while the instrument is in auto zero calibration mode, zero filter flushing is cancelled.
3) During zero filter flushing, only MODE key and ✳ key are enabled pressing either of these keys aborts zero filter flushing, and immediately the analog output hold is released, <HOLD> and <FLUSH> go OFF, and the <MAINT> contact output goes OFF.
4) Counting continues regardless of timer operation mode.
5) In <MAINT> mode, if the “zero filter flushing counter” reaches its “count up” setting then zero filter flushing is cancelled - not triggered - that time: the timer is reset and counting restarts.

7.3 Span Calibration

NOTE

Before performing span calibration, confirm that the electrode does not remain exposed to the air as after zero calibration, and the electrode rotates normally in the measuring tank.

When both the zero point and span are calibrated, calibrate first the zero point and then the span.

There are two span calibration methods. One is a sampling method in which the reading of the FC400G is adjusted to the value obtained by manual analysis. The other is a standard solution method in which the reading is adjusted to the concentration value of calibration standard solution (free chlorine concentration of approx. 80% of the output range).

Use of the sampling method is suitable to calibrate the FC400G more correctly, for example, when always measuring near-zero low concentrations of free chlorine. In general, there is no practical problem with span calibration using the sampling method.

The sampling method takes less effort than the standard solution method. Note that the electrode sensitivity is required to be initialized at start-up or when performing calibration immediately after the indicator electrode is replaced. The electrode sensitivity can be initialized by setting the service code 08 to "1" for "initialize electrode sensitivity." However, calibration after initializing the electrode sensitivity is performed unconditionally. Before performing span calibration, be sure to confirm that the electrode mechanism block has been placed back into the measuring tank and is ready for measurement.

Note: To initialize the electrode sensitivity, press the (YES) key when "CHANGE" is displayed in the message display when entering the <CAL> mode. (When "NO.CHGN" is displayed, press the (NO) key to display "CHANGE" and then press the (YES) key.)

7.3.1 Span Calibration Using Sampling Method

Span calibration using the sampling method can be performed as follows.

Note: Before performing span calibration, confirm that the electrode does not remain exposed to the air as after zero calibration, and the electrode rotates normally in the measuring tank.

Start span calibration at the point when zero calibration using the method in Sec. 7.2.1 or 7.2.2 is finished and "SPAN" is displayed in the message display.

Note: When calibration described in Sec. 7.2.1 is performed, the FC400G is in the MEAS mode (or in the <HOLD> mode) and "SPAN" is not displayed. Refer to (b) in Sec. 5.4.1 and display "SPAN" in the <CAL> mode.

(1) Press the (YES) key to enter the span calibration mode.
Free chlorine concentration is displayed in the data display.

(2) Collect sample water for performing manual analysis.
Confirm that the free chlorine concentration of the sample water remains stable before span calibration is finished. Collect sample water for performing manual analysis by opening the drain cock on the measuring tank.
Collect sample water while observing the liquid surface in the measuring tank to make sure the tip of the counter electrode (silver chloride electrode) is not exposed to the air.

Note: If the counter electrode is exposed to the air, the reading will drop to zero, and when the counter electrode is re-immersed into the sample water, it will take some time (usually several minutes) before the reading stabilizes. If it is accidentally exposed to the air, confirm that the reading has returned to the original value and is stable and perform the operation in item (4).

(3) Measure the free chlorine concentration of the sample water using manual analysis (e.g., an amperometric titration method).
The free chlorine concentration of the sample water changes over time. Perform manual analysis immediately after collecting sample water.

(4) Enter the obtained value in the data display and perform span calibration.
Confirm that the obtained value has been entered correctly and press the (ENT) key. This causes

the mg/l (or ppm) indication to blink during calibration operation. When the span calibration is completed normally, “CAL.END” appears.

Note: If an error occurs during calibration operation, “END.E5” or “END.E7” is displayed in the message. When this message is displayed, take countermeasures, referring to Sec. 7.4.

(5) Press the YES key to end the calibration and switch the FC400G to the MEAS mode. Press the YES key to switch the FC400G to the <MEASURE> or <HOLD> mode (“HOLD. ON” in the message display). When “HOLD.ON” is displayed, press the NO key to select the <MEASURE> mode.

7.3.2 Span Calibration Using the Standard Solution Method

Note: To prepare standard solution, the following materials are required: approx. 2 to 3 liters of pure water, approx. 20 to 30 milliliters of pH7 buffer solution, approx. 100 to 150 mg of NaCl, and commercially available sodium hypochlorite, or NaClO (the quantity of which is so much that a free chlorine concentration of approx. 80% of the output range can be obtained by dilution).

Span calibration using the standard solution method is performed as follows.

Note: Before performing span calibration, confirm that the electrode does not remain open to the air as after zero calibration, and the electrode rotates smoothly in the measuring tank.

Start span calibration at the point when zero calibration using the method described in Sec. 7.2.1 or 7.2.2 is finished and “SPAN” is displayed in the message display.

Note: When calibration is performed using the method in Sec. 7.2.1, the FC400G is in the MEAS mode (or <HOLD> mode) and “SPAN” is not displayed. Refer to (2) of Sec. 5.4.1 and display “SPAN” in the <CAL> mode.

(1) Press the YES key to enter the span calibration mode.
Free chlorine concentration is displayed in the data display.

(2) Prepare standard solution.
First prepare a solution to dilute commercially available sodium hypochlorite solution. Prepare a solution for dilution so that it consists of 10 milliliters of pH7 standard solution and 50 milliliters of NaCl per one liter of pure water. Calibration requires 2 to 3 liters of dilution solution. Prepare a standard solution by diluting the sodium hypochlorite solution using the dilution solution so that the free chlorine concentration is approx. 80% of the output range.

Notes: • To prepare a standard solution, sample water may be used instead of dilution solution.
• To prepare a span calibration solution according to the official method, dilute the sodium hypochlorite using tap water so that the free chlorine concentration is approx. 80% of the output range

(3) Supply the standard solution to the detector.
When the zero point has been calibrated using the open input circuit method, close the needle valve at the sample water inlet of the detector and remove the sample water piping from the joint of the measuring tank. Set the tubing and hardware so that sample water can be supplied at a flow rate of at least 100 ml/min using a head difference or a pump and connect it to the detector at the sample water inlet.
When zero point has been calibrated using the chlorine-free-water-based measurement method, supply standard solution using the hardware used for the zero calibration.

(4) Measure the free chlorine concentration of the standard solution correctly using manual analysis (e.g. an amperometric titration method). The exact free chlorine concentration of the standard solution changes over time. Perform the operation in item (5) immediately after the manual analysis is finished.

(5) Enter the obtained value in the data display and perform span calibration.
Confirm that the obtained value has been entered correctly and press the ENT key. This causes the mg/L (or ppm) indication to blink during calibration operation. When the span calibration is completed normally, “CAL.END” appears.

Note: If an error occurs during calibration operation, “END.E5” or “END.E7” is displayed in the message display. When this message is displayed, take countermeasures, referring to Sec. 7.4.

(6) Reattach the tubing to the detector. Open the needle valve to allow the sample water to flow. Adjust the aperture of the needle valve so that the sample water flows at the specified flow rate.

(7) Press the YES key to end the calibration and switch the FC400G to the MEAS mode. Press the YES key to switch the FC400G to the <MEASURE> or <HOLD> mode ("HOLD. ON" in the message display). When "HOLD.ON" is displayed, press the NO key to select the <MEASURE> mode.

7.4 Remedies When Errors Occur in Zero or Span Calibration

7.4.1 If Errors occur during Calibration

If error occurs during zero or span calibration, the FC400G free available chlorine analyzer displays FAIL on the LCD and generates an error message as follows:

(1) During Zero Calibration
"END.E6" : Zero point error (Err.6)
"END.E7" : Response error during the calibration (Err.7)

(2) During Span Calibration
"END.E5" : Slope error (Err.5)
"END.E7" : Response error during the calibration (Err.7)

Note : If multiple errors occur, the error with the highest priority appears.
Priority is Err.5 > Err.6 > Err.7.

7.4.2 Remedies When an Error Occurs

(1) Press the NO key to perform calibration again and confirm that the error does not occur again.

(2) If the error occurs again, refer to Sec. 9.1 and remove the cause of the error, and then perform calibration.

Note: When an error occurs, the concentration value based on the calibration data is displayed. Also, the error message and "FALL" remain displayed in the <MEASURE> mode. These indications will not disappear unless the cause is removed.

NOTE

Slope error (Err.5) generated when span calibration is performed using manual analysis except the amperometric titration (AT) method

Initial electrode sensitivity (set at the time of shipment) is established based on the AT method. When span calibration is performed based on a manual analysis method (such as OT or DPD method) other than the AT method, a slope error [END.E5 (Err.5)] may occur due to the difference between the detecting sensitivity of the AT method and that of another method. In that case, initialize electrode sensitivity and perform span calibration.

If no error occurs during manual analysis other than the AT method, there is no practical problem even when the initial sensitivity set at the time of shipment is not changed.

Note: To initialize the electrode sensitivity, set service code 08 to "1" for "initialize electrode sensitivity" before performing calibration [refer to Sec. 5.4.2(f)].

8. INSPECTION AND MAINTENANCE

This chapter describes the inspection and maintenance required to maintain the FC400G operation in good condition.

8.1 Inspection and Maintenance Items and Implementation Cycle

The table below shows the principal inspection and maintenance items and recommended maintenance intervals to maintain good operating condition.

Actual maintenance intervals must be determined in accordance with individual operating conditions.

Table 8.1 Inspection and Maintenance Items and Implementation Cycle

Inspection and Maintenance Items	Implementation Cycle
● Polishing of indicator electrode	Monthly
● Replacement of indicator electrode	Once a year
● Ceramic beads cleaning	Every 3 months
● Replacement of ceramic beads	Once a year
● Measuring tank cleaning	Every 3 months
● Calibration	Monthly
● Replacement of activated charcoal filter	Once a year

Note: Appropriate maintenance intervals must be determined in accordance with the condition or contamination. Same applies (to decrease of influence of) combined chlorine insensitive version with gold alloy electrode and glass beads.

8.1.1 Polishing the Indicator Electrode

The indicator electrode constantly rotates at 600 rpm (at 50 Hz) and is automatically continuously polished with ceramic beads. However, this does not completely prevent adhesion of contamination; contamination gradually accumulates on the electrode surface over time.

A contaminated electrode surface is a cause of measurement error. The degree of this measurement error increases depending on the amount of contamination. Therefore, the electrode surface must be polished using abrasive (alumina) to remove such contamination before measurement error exceeds the allowance.

Polishing frequency differs with the quality of the sample water. Polishing every a few months may be sufficient in some cases. However, in general, it is recommended that the indicator electrode be polished every month. For polishing procedure, follow Sec. 6.1.4, when the electrode is polished, zero point and span must always be calibrated.

While the indicator electrode rotates at 600 rpm (at 50 Hz), the electrode is automatically polished with ceramic beads. However, this does not completely prevent adhesion of contamination; contamination gradually accumulates on the electrode surface over time. Therefore, the electrode surface must be polished manually with polishing powder (alumina) to remove such contamination before the measurement error exceeds the allowance. For the polishing procedure, follow Sec. 6.1.4. In particular, polish the electrode surface as described when it has become corrugated or deformed from the original shape (circle with a diameter of about 3 mm).

Note: It is recommended to polish the indicator electrode every month. Every two or three months may be sufficient in some cases; the required polishing frequency differs with the quality of the sampling water. After polishing the electrode surface, conduct calibration with running-in operation.

(1) Press the MODE key on the converter to enter the operation level and press the YES NO key to select the <CELL> mode (cell motor ON / OFF). Press the NO key with respect to the message “CELL ON” displayed to stop the rotation of the indicator electrode.

When the electrode stops rotating, the CELL lamp extinguishes.

Remove the electrode mechanism block from the measuring tank and set up the block as shown in Figure 8.2. The electrode mechanism block is fixed to the measuring tank using two screws at the lower part of the mechanism block.

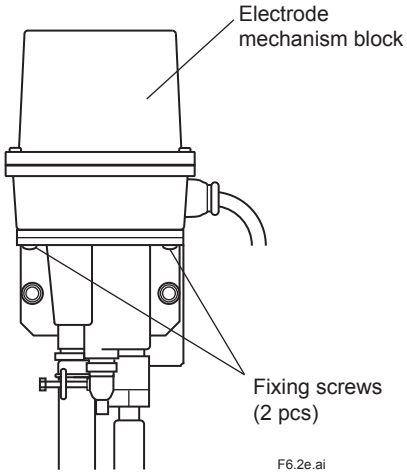


Figure 8.1 Electrode Mechanism Block Fixing Screws

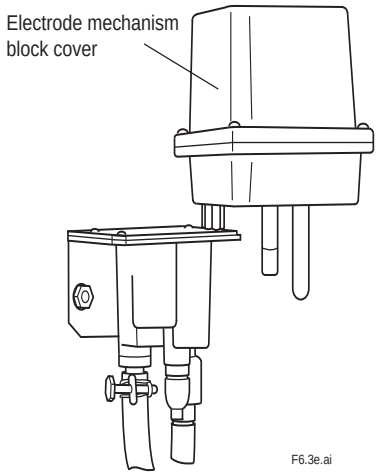


Figure 8.2 Under Maintenance

(2) Removing the Indicator Electrode
Remove the electrode mechanism block cover from the detector. Hold the gears so that the drive shaft does not turn and remove the indicator electrode. The electrode is screwed into the drive shaft; turn the electrode counterclockwise. In so doing, do not touch the brush. Also, exercise care so that you do not touch the electrode surface of the indicator electrode.

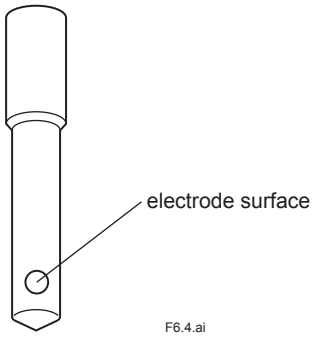


Figure 8.3 Appearance of the Indicator Electrode

(3) Polishing the Electrode Surface of the Indicator Electrode
Spread the provided abrasive (alumina) onto dampened gauze and thoroughly clean the electrode surface using such gauze so that any contamination such as oil and grease is completely removed. Then wash off any abrasives adhering to the electrode in clean running water.
After polishing and cleaning, confirm that contamination has been completely removed.
The clean electrode surface must be uniformly wetted.

Note: Polish the electrode surface by following the instructions below when it has become corrugated or deformed from the original shape (about 3 mm in diameter). Polish the electrode surface with sandpaper (about #600) until the surface becomes finely rounded. Then, polish it with sandpaper (about #2000), and lastly with polishing powder (alumina). Make sure the electrode surface is clean and then install the indicator electrode. Reduce the amount of ceramic beads if the electrode has deformed greatly. The ceramic beads are normally filled up to the bottommost notch of the beads case when the indicator electrode is inserted.

(4) Installing the Indicator Electrode
Hold the gears so that the drive shaft does not turn, and sufficiently screw the electrode into the shaft. During installation, exercise care not to touch the electrode surface.

Note: Polish the electrode surface again if you have touched it.

8.1.2 Cleaning the Ceramic Beads and Measuring Tank

Contaminated ceramic beads reduces the effects of cleaning of the indicator electrode, and may possibly cause electrode contamination.

Clean the ceramic beads periodically. Also, simultaneously clean the measuring tank.

Clean them as follows:

(1) Turn OFF the power switch provided in the power line or remove the fuse provided, in the converter to stop the free available chlorine analyzer.

Note: Be alert to the fact that even if the fuse is removed, live voltage remains on one side of the AC power line.

(2) Unscrew two screws fixing the electrode mechanism block to remove the mechanism block from the measuring tank.

(3) Remove the beads case, containing the ceramic beads, from the measuring tank. In so doing, remove the beads case cover together with the beads case.

(4) Clean the measuring tank.
Using a brush and neutral detergent, sufficiently remove contamination from the measuring tank. For adhesion of manganese or iron, use diluted hydrochloric acid. Finally, wash off the detergent from the measuring tank using water.

Note: Never attempt to use organic solvent for cleaning,

(5) Pour the ceramic beads into another container, remove contamination using diluted hydro chlorine acid, and sufficiently wash the beads with water.

(6) Clean beads case, and beads case cover.
For the beads case and beads case cover, clean both in the same manner as measuring tank cleaning in item (4).

Note: The beads case cover may turn whitish during prolonged use; however, it causes no functional problem.

(7) Set the beads case cover onto the beads case and pour the cleaned ceramic beads into the beads case. In this case, if the amount of beads is below the notch in the beads case cover (approx. 40 mm from the bottom), replenish the ceramic beads up to that level.

Note: Ceramic beads undergo wear during long use, reducing the cleaning effect; it is recommended that the ceramic beads should be replaced every year. reached a steady state.

(8) Return the electrode mechanism block in place and firmly tighten the two fixing screws.

(9) Turn ON the power switch (or return the fuse in place) to restart operation.

8.1.3 Calibration

After polishing the indicator electrode, calibrate the zero point and span in the manner described in Chapter 7.

It is recommended that calibration be conducted every month in the initial stage of FC400G operation to determine the degree of contamination on the indicator electrode. This may be a guidance for determining appropriate maintenance intervals.

8.1.4 Replacement of Activated Charcoal Filter

(1) Close BV1 and BV2, then rotate filter case to remove (see Figure 8.4).

(2) Clean inside of case with brush or the like.

(3) As illustrated in Figure, replace filter with new one.

(4) Reassemble using the reverse procedure, then open BV3 and BV1 to pass water through filter. Check that there are no water leaks from filter and piping, and no bubbles in drain water.

(5) Operate for about 20 min. then confirm that free available chlorine analyzer reading is near zero.

(6) Close BV3 and open BV2 ball valve.

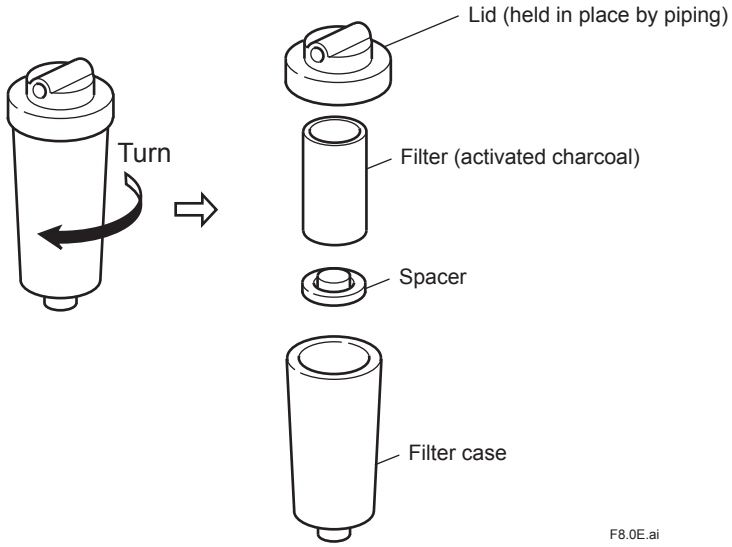


Figure 8.4 Replacing Activated Charcoal Filter

8.2 Checking the Electrode Mechanism Block, and Replacing Damaged Parts

Detector electrode parts such as the motor assembly and driven shaft assembly have finite life. If conditions of use or environment are outside of specifications, their life may be shorter than would otherwise be expected.

Periodically check whether electrode mechanism block is operating normally. To check if abnormal or not, refer to “Main Check List”; for a simple check whether calibration and the like is abnormal, refer to “Auxiliary Check List”. Alternate these checks for best results.

When such parts that are subject to aging have been operated for their “recommended lifetime”, it is recommended that you replace them even if you feel that there is still life left in them.

Table 8.2 shows a list of parts that we recommend you to periodically check and replace.

Table 8.2 Parts recommended for periodic checks and replacement

Part	Recommended check interval	Recommended replacement interval
Brush and slip ring	3 months	2 years or if characteristic without range
Drive belt	6 months (sub; 3 months.)	3 years operation
Driven shaft assembly	6 months (sub; 3 months.)	3 years operation
Motor Assembly / gear head	6 months (sub; 3 months.)	3 years operation

8.2.1 Inspecting the Brush and Slip Ring

CAUTION

Do not touch the brush except when replacement is performed.

When the electrode mechanism block cover is removed, for example, for polishing of the indicator electrode, also visually check the driven shaft slip ring and the brush contacting the ring for abnormalities such as abrasion.

Further, measure resistance between the brush wiring terminal and driven shaft, using a tester. It is acceptable when the resistance is 500 Ω or less with the indicator electrode operating.

If the resistance exceeds 500 Ω, remove any grime from the slip ring using an alcohol dampened cotton swab and re-measure the resistance.

If abnormality such as slip ring wear or bent brush is detected or if the resistance between the brush wiring terminal and driven shaft is unable to recover to below 500 Ω the slip ring and brush must be replaced. In general, contact Yokogawa service for their replacement.

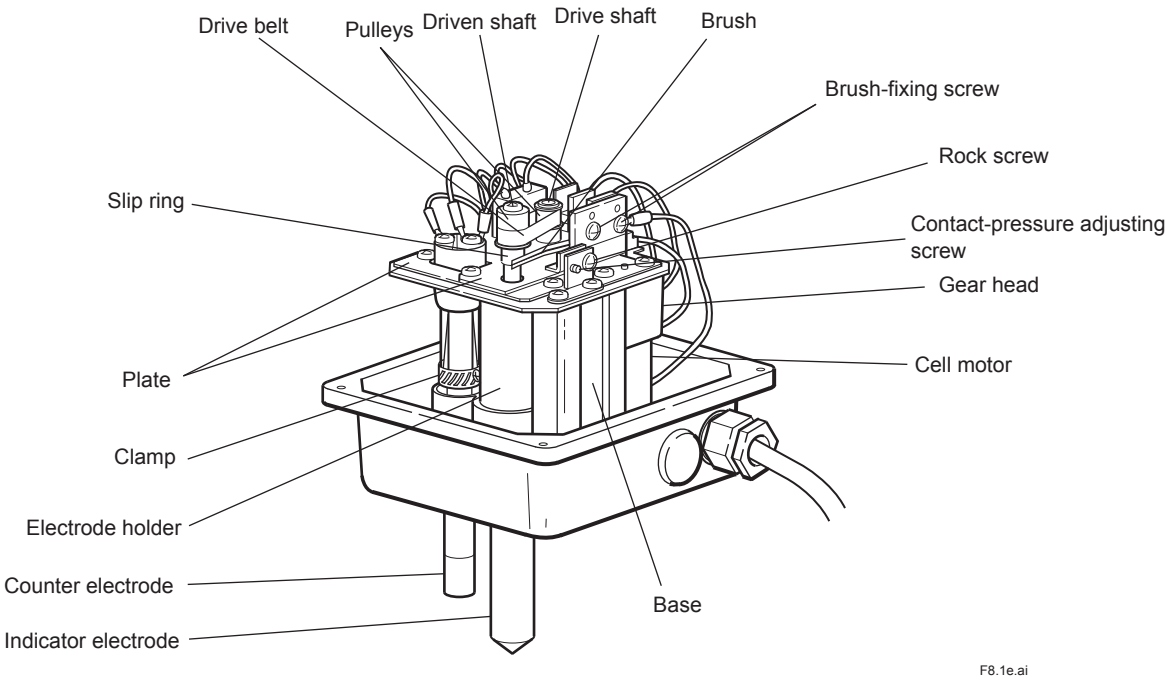


Figure 8.5 Electrode Mechanism Block

If they are replaced by the customer, follow the steps below.

(1) Shut off the power fed to the free available chlorine analyzer to stop the operation.

(2) Remove the brush by unscrewing the two screws firing the brush (one of them is also used as wiring terminal).

(3) Remove the two pulleys of the drive shaft (cell motor shaft) and driven shaft (indicator electrode-mounting shaft).
The driven shaft pulley can be removed by inserting a 2 mm nominal size Allen wrench (accessory) into the hole in the shaft, which is used as a lock, and unscrewing the end of the driven shaft. The drive shaft pulley can be removed by unscrewing two set screws using a 1.5 mm nominal size Allen wrench (accessory).
Remove the pulleys together with the drive belt.

(4) Remove the slip ring from the driven shaft and attach a new one onto the shaft.

(5) Install the pulleys and drive belt in place.
(Note) Mount the drive shaft pulley so that it is 0.3 to 0.7 mm from end of the shaft.

(6) Install a new brush, taking care not to deform it. Locate the hole in the brush to the positioning pin on the bracket and fix the brush using the two fixing screws. After installation, check that the probe at the tip of the brush contacts the slip ring and that the brush body does not contact the pulley.
If the brush probe does not contact the slip ring, the position of the brush mounting bracket must be adjusted so that the probe contacts the slip ring.

[Adjust the contact-pressure of the brush]

- First, loosen the two screws fixing the brush-mounting bracket and also the lock screw next to the contact-pressure adjusting screw.
- Then, by pulling the brush-mounting bracket towards you, screw in the contact pressure adjusting screw. The desirable screwing amount of the contact-pressure adjusting screw can be obtained when the screw is tightened by three and half turns after the brush has contacted the slip ring. Confirm that the brush is in contact with the slip ring by measuring the resistance using a tester.
- After the brush-mounting bracket has been located, screw in the lock screw and also the brush-mounting bracket fixing-screws.

(7) Feed power to the free available chlorine analyzer. Confirm that the driven shaft rotates smoothly. Also, measure the resistance between the brush wiring terminal and the driven shaft using a tester to determine that the resistance value is 500 Ω or less.

(8) Install the electrode mechanism block cover in place.

8.2.2 Check / Maintenance / Replacement of Drive Belt

When you polish the indicator electrode, and remove the electrode mechanism block cover for maintenance, check the drive belt as follows (once in three months recommended).

- Check for powder (from drive belt friction) deposited on motor mounting plate and the like.
  As the drive belt ages, and the mating of the teeth on the pulley with the teeth on the drive belt worsens, the amount of powder deposited increases.
- When the driven shaft pulley is rotated clockwise or anticlockwise, its small “play” causes the drive pulley to rotate. If the drive belt loosens and cannot transmit enough traction, the “ play” becomes larger.
  Once in six months you should perform the following checks and maintenance:
- Check if aging of the drive belt has caused cracking. If there is serious cracking, replace it.
- Check if the drive belt teeth are badly worn. If so, replace it.
- Check if powder from the drive belt is stuck to drive shaft or driven shaft.
  If this powder is adversely affecting pulley operation, remove for cleaning. When cleaning the pulley, also clean powder from the drive belt off the motor mounting plate.

[Replacing the Drive Belt]

When replacing the drive belt, the tension in the drive belt needs to be adjusted or the drive belt like may be adversely affected. Because this adjustment is rather time - consuming and troublesome, it is recommended that, where possible - except when the drive belt is no longer rotating the electrode reliably, and needs to be urgently fixed - the driven shaft assembly and motor be replaced at the same time as the drive belt.

If you want to replace just the drive belt, refer to Sec. 8.2.3 (14) and (15).

8.2.3 Check/ Maintenance/ Replacement of Driven Shaft Assembly

[Checks and Maintenance]

At zero calibration time, operate the indicator electrode and check the following (once in three months recommended)

- Check if noisier that usual, or if vibration or non - continuous noises.
  If sound is abnormal, driven shaft assembly may be bad, or problem may be in motor. Stop electrode rotation, check if bearing at bottom of driven shaft is gone (see six - monthly check below).
- Check if vibration in driven shaft or indicator electrode.
  Usually the bushing (bearing) at the bottom is the cause. Stop the rotation and check (see six - monthly check below).
- Manually turn the driven shaft and confirm that it's as smooth as usual.
  If there is any clatter, if drive belt has come off or shaft does not rotate easily, or a rubbing noise is evident, promptly replace the driven shaft assembly.

[Replacing the driven shaft assembly]

If the bearing has become bad, replace the driven shaft assembly. In principle,this should be done by Yokogawa's service facility.

If the user wishes to replace it, the procedure is as follows:

Items (1) to (9) relate to disassembly, and items from (10) onwards relate to reassembly.

(1) Shut off the power fed to the FC400G, then place the electrode mechanism block in the maintenance position then remove the cover from the electrode part.

(2) Remove indicator electrode and counter electrode.
To remove the indicator electrode, inset the supplied Allen wrench into the socket of the driven shaft, to stop it from rotating.
Disconnect the three wires connected to the counter electrode, next loosen and remove the clamp holding the electrode in its holder.

(3) Remove the brushes. Remove the two screws holding the brushes (one also holds wiring terminal).

(4) Remove the bracket which holds the brush by loosening the 2 screws which holds the bracket, and remove the rock screw at side of contact-pressure adjusting screw.

(5) Remove the drive belt. Individually remove from the pulleys on driven shaft and drive shaft.

(6) Remove slip ring from driven shaft.

(7) Remove the plate installed to prevent drive belt shavings to enter the electrode holder in the driven shaft assembly by loosening the 2 screws.

(8) Remove two plates which holds driven shaft assembly in place.

(9) If driven shaft assembly is bad, remove it from motor mounting plate. The place where the electrode holder base is inserted contains an O-ring. This O-ring and the counter electrode fixing clamp can be reused.

Note: Even if the O-ring (part no. Y9115XB) is not damaged, it is recommended to replace it after 3 years use.

The following, from item (10) below onwards, is the procedure for reassembly.

When reassembling, observe the following cautions:

- Clean any dirt off parts before reassembling.
- Adjust drive belt tension to 4 N (0.4 kgf).
- When reassembling, make sure that indicator electrode does not make contact with its base.

(10) Assemble new driven shaft assembly on motor mounting plate. First, install the clamp and O-ring in the electrode holder in the driven shaft assembly. The O-ring should be installed in the position of approximately 4 mm from the end of the electrode holder. Next, mount the driven shaft assembly on the motor mounting plate, taking care not to allow the O-ring to protrude from the hole in the base.

(11) Mount plate that holds driven shaft assembly in place. Confirm that four pins on plate surround electrode holder and, as a temporary measure, loosely tighten the two screws in the lengthwise direction.

(12) Replace plate that keeps dust from drive belt out of driven shaft assembly electrode holder. With the two bumps on the plate facing down, pass the plate under the driven shaft and index the two bumps with the two holes in the plate mounted in step (11). Then, as a temporary measure, loosely tighten the two screws that hold it in place.

(13) Mount the slip ring on the driven shaft.

(Note) The driven shaft and slip ring need to be in contact and make a good electrical connection, so make sure that they are clean.

(14) With the drive belt mounted, attach pulleys to the drive shaft and driven shaft.

(Note) Mount the drive shaft pulley so that it is 0.3 to 0.7 mm from end of the shaft, so that drive belt can lie horizontal.

(15) Adjust drive belt tension and tighten screws that were loosely tightened in (11) and (12).
The 1.00 kg spring plate should fit in the hole in the hook part of the driven shaft to pull the hook of 4 N (0.4 kgf) horizontal force.

(16) Mount indicator electrode on driven shaft, and check that indicator electrode is not contacting the base.

(Note) If the indicator electrode is contacting the base, or if the hole in the center of the base and the center of the indicator electrode are not aligned, loose the four screws on the motor mounting base and adjust.

(17) Remount counter electrode, reconnect wiring, and fix clamp.

(18) Mount brush.
If motor mounting plate was loosened in (16), adjust brush to split ring contact pressure to optimum value (see Sec. 8.2.1)

This completes the replacement procedure. Check that when power is applied to the FC400G, the drive shaft, drive belt, and driven shaft rotate smoothly. Confirm that there are no abnormal sounds, like vibration or discontinuous noises.

8.2.4 Check / Maintenance / Replacement of Motor and Gear Head

[Procedure for Checking and Maintenance]

At zero calibration time, operate the indicator electrode and check the following. (once in three months recommended)

- Check there's no irregularity in rotation speed of drive shaft. If there's any irregularity, loose the load on the shaft by loosening the screws which fix the driven shaft pulley, and recheck. If there is still irregularity, replace motor and gear head. If the irregularity doesn't reappear, check the driven shaft assembly.
- Abnormal sound from gear head (motor).
  If there's any abnormal sound, check the motor / gear head. (In principle, this should be done by Yokogawa).
  Also, approximately once in six months, check the following items as well:
- Motor rated torque and drive torque.
  In <CELL> mode, when motor is turned ON/OFF, after the ON command it should quickly reach speed. Confirm that the difference in speed of rotation between its normal status, and when load is reduced by loosening screws fixing pulley to driven shaft, is not noticeable.
  If operation is still not satisfactory, replace motor and gear head.

[Replacement procedure]

Replacement of motor and gear head should, in principle, be carried out by Yokogawa service.

If you want to do it yourself, the procedure is as follows:

- In principle, replace motor and gear head at the same time as periodic replacement of other parts. Replace complete motor assembly consisting of both motor and capacitor.
- When replacing motor assembly and gear head, first remove motor mounting plate from base.

There are no special cautions relating to removal of, or reassembly of, motor assembly and gear head, however the parts such as electrode, brushes and drive belt removed when removing motor from mounting plate should be carefully reassembled, referring to Sec. 8.2.1 through Sec. 8.2.3, so as not to make any mistakes in reassembly.

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9. TROUBLESHOOTING

9.1 When <failure> is Indicated

Daily maintenance for maintaining good FC400G operation is described in Chapter 8; this chapter sets forth how to maintain the FC400G in the event of error.

9.1.1 Indication of Error Message or Error Code

Types of <failure> and respective error messages / error codes are listed in Table 9.1.

- Errors occurring during Measurement
  If error occurs during measurement, the LCD displays an error message (Err.) and FAIL .
  The FC400G also generates fail contact output (fail LED lights).
- Errors occurring during Maintenance
  If error occurs during maintenance (during zero and / or span calibration, or during plateau characteristic collection), the LCD displays an error message (Err.) and FAIL to inform the operator of error signal occurrence. However, no fail contact output is generated and output signal overshooting does not function.
- Error occurring during Data Setting
  If data set during data setting is incorrect, an error message (NOTE.) appears for approx. 2 sec to inform the operator of incorrect data setting. In this case, set data does not update the previous; set correct data again.

Table 9.1 Error Message List

Error No.	Error Content	Classification
Err. 1 Err. 2	Diffusion current value exceeded Sample temperature error	Occurs during measurement or maintenance.
(Err. 3)	Reserved error code (presently not used)	
Err. 4	Applied voltage error	Occurs during measurement or maintenance.
Err. 5 Err. 6 Err. 7	Slope error Zero point error Response error during zero or span calibration	Occurs during maintenance (however, only during zero or span calibration).
Err. 8 (Note 1)	Temperature compensation range exceeded	Occurs during measurement or maintenance.
(Err. 9)	Reserved error code (presently not used)	————
Err. 10	Converter failure	Occurs during measurement or maintenance.
NOTE. 01 NOTE. 02 NOTE. 03	Input data setting range exceeded Input data setting error Input data setting error	Occurs during data setting.

Note 1: This error Err.8 occurs only if exceeded temperature compensation range check is set to ON in service code 02.

9.1.2 Remedies When Errors Occurs

The possible cause of each error message is described in the following.
Take appropriate steps for each.

Err. 1: (Diffusion Current Value Exceeded)

"Err. 1" appears if the diffusion current during measurement exceeds the range of -9.00 to 26.00 µA.

Confirm if the applied voltage parameter value set in service code 07 is correct. Also, confirm that there is no grime or moisture adhesion resulting in insulation deterioration on the electrode cable connection.

Err. 2: (Sample Temperature Error)

"Err. 2" appears if sample temperature exceeds the range of 0.0 to 50.0°C.

Control sample temperature to be in the range of 0.0 to 50.0°C.

If the error indication fails to extinguish even when the sample temperature is in the range of 0.0 to 50.0 °C, RTD is possibly defective (open circuited). In this case, replace the counter electrode.

Err. 4: (Applied Voltage Error)

"Err. 4" appears if the applied voltage output exceeds the range of -1.5 to 1.5 V.

Confirm if the applied voltage parameter value set in service code 07 is correct.

Err. 5: (Slope Error)

"Err. 5" appears if the initial sensitivity value (value set to initialize electrode sensitivity in service code 08) exceeds the range of 50 to 120% when the slope is confirmed during calculation in span calibration.

The calibration standard solution used for span calibration may have aged, entering the incorrect concentration value, or the indicator electrode may have deteriorated.

Confirm the presence of any of these.

If the error still fails to extinguish even when re-calibration is made using a new calibration standard solution or after the indicator electrode has been polished using alumina, the indicator electrode must be replaced.

Err. 6: (Zero Point Error)

"Err. 6" appears if the zero point exceeds ± 1.00 µA when the zero point is confirmed during calculation in zero calibration.

Chlorine may enter the chlorine-free water used for the calibration (when the chlorine-free-water-based measuring method applies), or the indicator electrode or counter electrode may be defective. Confirm if any of these is the cause.

Err. 7: (Response Error during Zero and / or Span Calibration)

"Err. 7" appears if concentration does not stabilize within "*CT. min" (stabilization setup time) set in service code 04 during zero and / or span calibration.

Confirm response recovery after the indicator electrode has been polished using alumina. Also, confirm that the set values of stability determination parameters "*ΔT. SEC", " *ΔPPM ", and "*CT.min" set in service code 04 are correct. If the parameters are correct, but still no response recovery, the indicator electrode may have deteriorated.

Replace the indicator electrode.

Err. 8: (Temperature Compensation Range Exceeded)

"Err. 8" appears if sample temperature exceeds the temperature compensation range of 0.0 to 40.0 °C.

Control sample temperature to be in the range of 0.0 to 40.0°C.

Note: Exceeded temperature compensation range check is available only when temperature compensation range fail ON is selected in service code 02.

Err. 10: (Converter failure)

The FC400G free available chlorine analyzer has become defective. Contact Yokogawa service.

NOTE. 01: (Input Data Setting Range Exceeded)

This error appears if a set value exceeds the relevant setting range when data is set in the operation level, setting level, or service level.

If this error message appears, the relevant data will not be updated. Set correct value again.

NOTE. 02: (Input Data Setting Error)

This error is generated if the mg/l (or ppm) value for 100% signal output falls below 1.00 mg/l (or 1.00 ppm) in the <*OUTPU> mode in the setting level.

If this error message appears, the relevant data will not be updated. Set correct value again.

NOTE. 03: (Input Data Setting Error)

This error is generated if the mg/l (or ppm) value for 100% signal output is set to a value below the value for 50% signal output when two-line-segment output is set in service code 05 in the <*OUTPU> mode in the setting level.

If this error message appears, the relevant data will not be updated. Set correct value again so that the mg/l (or ppm) value for 100% signal output exceeds the value for 50% signal output.

9.2 For the Case Where No Error Indication Appears

There are cases where normal measurement is prevented, such as in fluctuating set value even though no error is detected. Table 9.2 shows such abnormalities, possible causes, and remedies.

Table 9.2 Abnormalities, Their Possible Causes, and Remedies

Abnormalities	Possible Causes	Remedies
Measured value is abnormal.	1. Indicator electrode has stopped. a. Electrode drive belt does not turn. b. Cell motor does not run. 2. Indicator electrode has won out. 3. Insufficient continuity between the contact brush and slip ring at the electrode mechanism block 4. Input circuit current leaks	1. Take steps as follows : a. Sufficiently tighten the set screw. b. Replace the motor with a new one. 2. Replace the electrode with a new one. 3.a. Adjust the brush contact pressure and remove wear debris from the slip ring (see Sec. 10.2.6). 3.b. Replace the brush and slip ring (see Sec. 8.2.1). 4. Check the electrode mechanism block to correct poor insulation. (Example of check point : insulation between the brush and base)
Measurement error is large.	1. Indicator electrode has been contaminated. 2. Zero and / or span has not been correctly adjusted. 3. Auto zero calibration abnormal.	1. Polish the indicator electrode in accordance with Sec. 8.1.1 also, clean the ceramic beads in accordance with Sec. 8.1.2 (if it is not possible to sufficiently clean the beads, replace them with new ones). 2. Conduct zero and / or span calibration. 3a. Replace activated charcoal filter 3b. Piping related to auto zero calibration is blocked
Measured value fluctuates largely.	1. Indicator electrode does not rotate at constant speed. 2. Insufficient continuity between the contact brush and slip ring at the electrode mechanism block	1. Check if the set screws have loosened. Also, check if the belt is normal. If not, replace the belt. 2.a. Adjust the brush contact pressure and remove wear debris from the slip ring (see Sec. 10.2.6). 2.b. Replace the brush and slip ring (see Sec. 8.2.1).
Measured value does not vary.	1. Measuring tank has no sample water. 2. Electrode to electrode circuit is open. 3. No voltage is applied between the indicator and counter electrodes.	1. Repair abnormality such as piping disconnection or sample water feed failure to normal condition 2. Repair open circuit. If open circuit occurs in an electrode, replace such electrode. 3. Check the converter.
Abnormal analog output	1. Lead resistance is too large. 2. Output circuit abnormal.	1. Reduce the resistance to 550Ω or less. 2. Contact YOKOGAWA.
The reading deviates significantly in the positive (or negative) direction, or overshoot occurs.	1. Span calibration has not been performed correctly. Span calibration was performed with electrode sensitivity initialization set to ON (1) in service code 08 ("CHANG" Mode) and using a calibration solution with a large difference in concentration from the input concentration value.	1. Set electrode sensitivity initialization to ON (1) in service code 08 ("CHANG" Mode) and perform calibration again. (See item (f) in Sec. 5.4.2, Sec. 7.3)

10. SPARE PARTS AND CONSUMABLES

10.1 Spare Parts and Consumables List

Name	Part No.	Description	Q´ty	Recommended replacement interval*
Indicator Electrode (Rotating electrode)	K9332MB	Gold electrode	1	Yearly
Indicator Electrode (Rotating electrode)	K9334JP	Gold alloy indicator electrode	1	Yearly
Counter Electrode	K9332MK	Silver chloride electrode	1	At the time of damage
Ceramic Beads	K9332ZP	For cleaning general type indicator electrode, 2 bags	1	Yearly
Glass Beads	K9332ZJ	For cleaning combined chlorine insensitive type indicator electrode, 2 bags / 1Q' ty	1	Yearly
Polishing Powder (Alumina)	K9088PE	For polishing indicator electrode	1	Yearly
Brush	K9332JX	Part for electrode mechanism block	1	2 years
Slip Ring	K9332JZ	Part for electrode mechanism block	1	2 years
Fuse	A1111EF	2A	1	Yearly
Driven Shaft Assembly	K9334JV	Part for electrode mechanism block	1	3 years
O-Ring	Y9115XB	Part for electrode mechanism block	1	3 years
Drive Belt	L9804UK	Part for electrode mechanism block	1	3 years
Motor Assembly (100 V)	K9334JY	Part for electrode mechanism block	1	3 years
Motor Assembly (110 V)	K9334VQ	Part for electrode mechanism block	1	3 years
Motor Assembly (200 V)	K9334VR	Part for electrode mechanism block	1	3 years
Motor Assembly (220 V)	K9334VS	Part for electrode mechanism block	1	3 years
Gear Head (100 V/110 V)	K9332JP	Part for electrode mechanism block	1	3 years
Gear Head (200 V/220 V)	K9334VA	Part for electrode mechanism block	1	3 years
Activated Charcoal Filter	L9862AY	For zero calibration	1	Yearly

* Replacement intervals vary depending on the application.

10.2 Spare Parts

10.2.1 Polishing Powder (K9088PE)

Used to remove contamination on the indicator electrode that cannot be removed by automatic cleaning using glass beads (ceramic beads). One bag of abrasive is provided for the FC400G.

10.2.2 Ceramic Beads (K9332ZP)

Used to replenish or replace the ceramic beads used for automatic cleaning of the indicator electrode when their amount diminishes below the specified level or their contamination can no longer be removed. The amount of the beads for replenishment or replacement differs with the FC400G operating conditions. Generally, approx. one to two bags of beads per year are required.

One bottle of ceramic beads is provided for the FC400G.

The same applies to glass beads (K9332ZJ) used in (to decrease influence of) combined chlorine insensitive version.

10.2.3 Indicator Electrode (K9332MB)

The indicator electrode is always polished with ceramic beads; it gradually wears and ultimately becomes unusable. This is the primary factor determining the life of the electrode. If the electrode does not become defective owing to any other problem, it will generally last for at least three to four years.

The abrasion-based life may be used as a guidance in providing for indicator electrode replacement. However, recommended practice is to keep one spare always available since the electrode could be inadvertently damaged or otherwise become defective.

The same applies to gold alloy indicator electrode (K9334JP) used in combined chlorine insensitive version.

Note : Refer to the following : cool storage requirements for electrically-conductive silicon grease for indicator electrode.

[Applying Electrically-conductive Silicon Grease to Indicator Electrode]

The indicator electrode needs to be electrically connected to the driven shaft.

This is achieved by applying electrically-conductive silicon grease to the tapped part of the indicator electrode.

Before use, check that this has been done. If not, apply silicon grease as follows. You can purchase 3 ml tubes of conductive silicon grease from Yokogawa, the part no. is K9044FX.

Be careful not to get this grease on the outer surface, particularly the gold surface.

Apply a small quantity (half a drop) of grease to a small flat screwdriver (about 3 mm wide blade) and apply to three equidistant places around the tapped hole, about 3 to 5 mm inside the tip.

Next screw the indicator electrode into this tapped (threaded) hole. Next unscrew the electrode and check that no grease has been extruded to the outer surface. If it has, remove it with a cloth that has been wetted with alkaline soap solution.

NOTE

If the conductive silicon grease gets on the electrode surface, then measurement accuracy is likely to be affected.

Conductive silicon grease needs to be applied only once.

10.2.4 Counter Electrode (K9332MK)

The counter electrode does not wear like the indicator electrode ; it can be continuously used without replacement.

However, recommended practice is to keep one spare always available, in case of accidental breakage.

10.2.5 Fuse (A1111EF)

Yearly fuse replacement in the converter is recommended to avoid unexpected operation stoppage.

10.2.6 Brush (K9332JX) and Slip Ring (K9332JZ)

CAUTION

Do not touch the brush except when replacement is performed.

As the brush in the electrode mechanism block is used in contact with the rotating slip ring, both parts are worn over a long time. Generally, replacement every two years is standard. As a rule, replacement should be made as a pair.

Procedures for adjusting the brush contact pressure and removing wear debris from the slip ring. Wear debris generated from the sliding action of the slip ring and brush (generated largely at the beginning), may enter between the slip ring and the brush, thereby temporarily increasing the contact resistance. This may cause a drop in readings. When this phenomenon occurs, polish and clean the surface of the slip ring to prevent the generation of wear debris and the ingress of wear debris generated into a space between the slip ring and the brush, and furthermore increase the contact pressure of the brush to the slip ring surface.

(1) Polishing and cleaning the surface of the slip ring
With the FC400G being powered, press sandpaper (#2000) on the rotating slip ring.
Then, press a cotton swab soaked in alcohol on the rotating slip ring to wipe off debris.

(2) Increasing the brush contact pressure
Turn off power to the FC400G. Loosen the lock screw next to the contact pressure adjusting screw and then the 2 fixing screws for the brush mounting bracket. Turn the contact pressure adjusting screw in 1/2 turn.
Tighten the lock screws and bracket fixing screws. Make sure that the brush does not come in contact with the pulleys and does not come off the slip ring. Then turn on the power.

10.2.7 Driven Shaft Assembly (K9334JV)

The two bearings on the driven shaft assembly are to ensure that it rotates smoothly.

The bearings will be worn gradually and so should be replaced after approximately three years operation.

Replacement should in principle be performed by Yokogawa.

(Note) It is recommended that the O-ring (Part no. Y9115XB) in the electrode holder in the driven shaft assembly should also be replaced at the same time.

10.2.8 Drive Belt (L9804UK)

This perishes and wears, and needs to be replaced after about three years operation.

10.2.9 Motor Assembly (See CMPL)

The rotating parts wear, and this needs to be replaced after about three years operation.

10.2.10 Gear Head (See CMPL)

The rotating parts wear, and this needs to be replaced after about three years operation.

10.2.11 Activated Charcoal Filter Element (L9862AY)

Used when auto zero calibration option is installed. It is recommended that the filter be replaced once a year.

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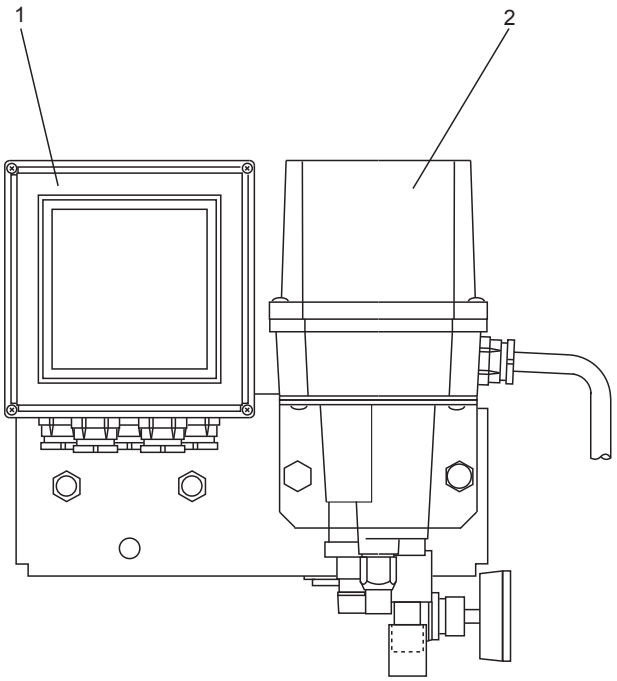
Customer Maintenance Parts List

Model FC400G
Free Available Chlorine Analyzer



Item	Part No.	Qty	Description
1	——	1	Converter (see page 2)
2	——	1	Detector (see page 3)

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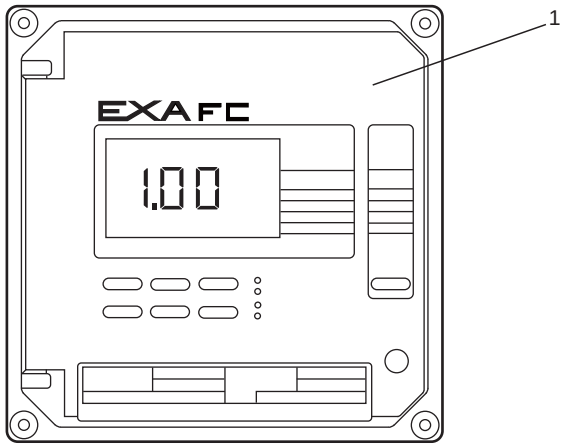
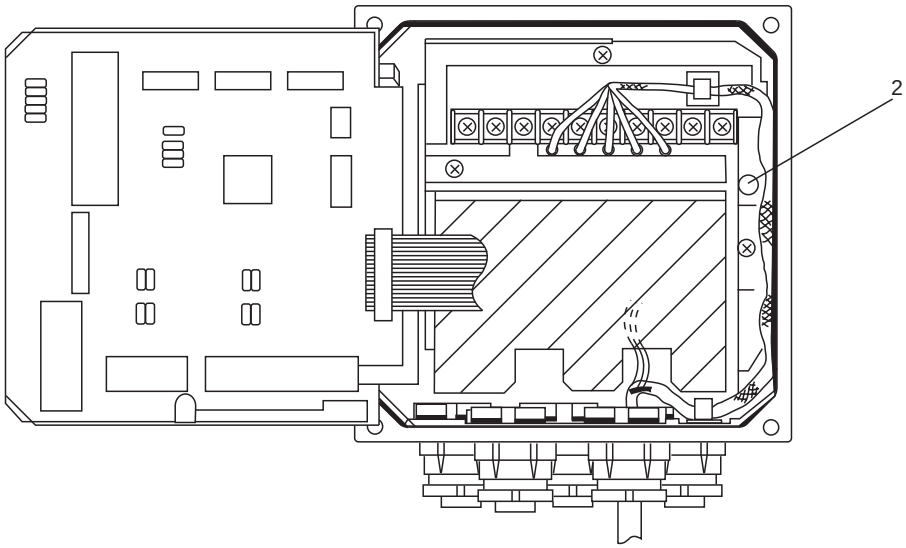
CMPL 12F05A01-01E
7th Edition : Jun. 2011 (YK)

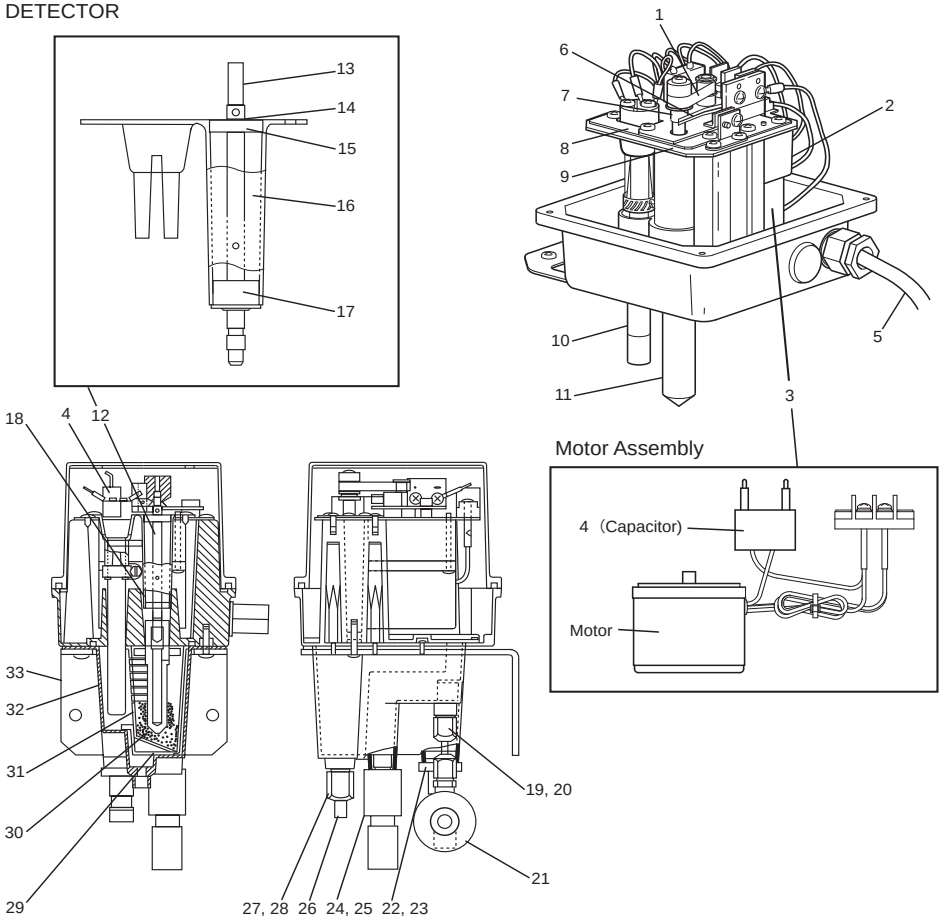
CONVERTER





Item	Part No.	Qty	Description
1	——	1	Converter (for Model FC400G - 65 to 68*A)
	——	1	Converter (for Model FC400G - 55 to 58*A)
	——	1	Converter (for Model FC400G - 65 to 68*A / PPM)
	——	1	Converter (for Model FC400G - 55 to 58*A / PPM)
2	A1111EF	1	Fuse (2A)

DETECTOR



Item	Part No.	Qty	Description
1	L9804UK	1	Drive Belt
2	——	1	Gear Head
	K9332JP		(For AC 100/110 V power supply)
	K9334VA		(For AC 200/220 V power supply)
3	——	1	Motor Assembly
	K9334JY		(For AC 100 V power supply)
	K9334VQ		(For AC 110 V power supply)
	K9334VR		(For AC 200 V power supply)
	K9334VS		(For AC 220 V power supply)
4	——	1	Capacitor
	K9334LK		(For AC 100 V power supply)
	K9332JS		(For AC 110 V power supply)
	K9334LP		(For AC 200/220 V power supply)
5	K9334KD	1	Cable
6	K9332JX	1	Brush
7	K9332JZ	1	Ring
8	K9334LM	1	Plate
9	K9334LL	1	Plate
10	K9332MK	1	Counter Electrode
11	——	1	Indicator Electrode
	K9332MB		(For general type)
	K9334JP		(For combined chlorine insensitive type)

Item	Part No.	Qty	Description
12	K9334JV	1	Shaft Assembly
13	K9334LN	1	Shaft
14	Y9500ET	1	Retainer-ring-E
15	L9805BG	1	Bearing
16	K9332LQ	1	Holder
17	K9334JW	1	Bearing
18	Y9115XB	1	O-Ring
19	L9831HC		Nut
20	L9831HE	1	Sleeve
21	L9852CB	1	Valve
22	K9332KQ	1	Nipple
23	Y9114XB	1	O-Ring
24	K9332KR	1	Cock Assembly
25	Y9110XB	1	O-Ring
26	K9332KP	1	Insert
27	L9831KL	1	Nut
28	L9831KN	1	Sleeve
29	K9332KZ	1	Beads Case Cover
30	——	1	Beads
	K9332ZP		(For general type)
	K9332ZJ		(For combined chlorine insensitive type)
31	K9332KX	1	Beads Case
32	K9332KL	1	Measuring Cell
33	K9332MS	1	Bracket

REVISION INFORMATION

- Title : Model FC400G Free Available Chlorine Analyzer (Non-Reagent Type)
- Manual No. : IM 12F5A1-01E

Apr. 2012/4th Edition

P. 1-3, Some revision of Figure 1.2.
P. 2-2, Some revision of service level code function. (*)
P. 2-5, Some revision of Note 2 for PH8HF MS-code and “2.3.3 Spare Parts”.
P. 3-3, Some revision of Figure 3.3.
P. 4-4, Some revision of “4.2.3 Modes in Service level”. (*)
P. 5-11, Some revision of “5.4.2 Modes in Service level and Selection of Their Setting Items”. (*)
P. 5-15 to 5-17, Some revision of (f) <*SERVC> Service level. (*)
P. 6-1, Some revision of “6.1.2 Filling with Ceramic Beads for Electrode Polishing”.
P. 6-3, Some revision of “6.1.4 Polishing the Indicator Electrode”.
P. 6-7, Some revision of Table 6.2 Setting Item List. (*)
P. 6-10, Some revision of Figure 6.5.
P. 6-11 to 6-12, Some revision of “6.3.3 Setting in the Service level”. (*)
P. 8-1 to 8-2, Some revision of “8.1.1 Polishing the Indicator Electrode”.
P. 8-4, Some revision of Figure 8.4.
P. 8-5, Some revision of Figure 8.5.
P. 8-6, Some revision of “8.2.2 Check / Maintenance / Replacement of Drive Belt”.
P. 8-7 to 8-8, Some revision of “8.2.3 Check/ Maintenance/ Replacement of Driven Shaft Assembly”.
P. 9-1, Some revision of “9.1.1 Indication of Error Message or Error Code”. (*)
P. 10-1, Some revision of “10.1 Spare Parts and Consumables List”.
P. 10-3, Some revision of “10.2.9 Motor assembly (See CMPL)”, “10.2.10 Gear head (See CMPL)”.
CMPL 12F05A01-01E revised to 7th edition (item 3 P/N of page 3 changed).
(*) Service code 03 description corrected.

Mar. 2011/3rd Edition

Remake and all pages changed.

Feb. 2003/2nd Edition

Stanchion model changed. Combined chlorine insensitive version option /CC, operation for auto-zero calibration, etc added. All pages changed.

Jan. 1993/1st Edition

Newly published.

■ If you want to have more information about Yokogawa products, you can visit Yokogawa's home page at the following web site.
Home page: http://www.yokogawa.com/an

User's Manual

Model FC400G
Free Available Chlorine Analyzer
Supplement

Thank you for selecting our FC400G Free Available Chlorine Analyzer (Non-Reagent Type).
The User's Manual IM12F5A1-01E 4th edition supplied with this product has been amended as follows, please make a note in your copy.

Revisions:

- Page 2-3, Some revision of “2.1 Standard Specifications”, EMC (Australia and New Zealand and KC Marking) added.
- Page 2-5, Some revision of “2.3.3 Spare Parts”.
- Page 6-1, Some revision of “6.1.2 Filling with Ceramic Beads for Electrode Polishing”.
- Page 6-3, Some revision of “6.1.4 Polishing the Indicator Electrode”.
- Page 8-2, Some revision of “8.1.1 Polishing the Indicator Electrode”.
- Page 8-3, Some revision of “8.1.2 Cleaning the Ceramic Beads and Measuring Tank”.
- Page 8-9, Some revision of “8.2.4 Check / Maintenance / Replacement of Motor and Gear Head”.
- Page 10-1 to 10-2, Some revision of “10 SPARE PARTS AND CONSUMABLES”.

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IM 12F5A1-01E
4th Edition

Ambient humidity: 5 to 95% RH (no dew condensation allowed)

Storage Temperature: -30 to 70°C

Installation: Indoor (Outdoor use separately requires rainproof measures.) (Direct sunlight must be avoided.)

Utility:

Power supply; 100 V AC ±10% 50/60 Hz
110 V AC ±10% 50/60 Hz
200 V AC ±10% 50/60 Hz
220 V AC ±10% 50/60 Hz

Power consumption; Approx. 15 VA

Mounting: 2B pipe mounting or wall mounting

Weight: Approx. 6 kg

EMC Regulatory Arrangement in Australia and New Zealand:

EN 55011 Class A, Group 1

KC Marking: Korea Electromagnetic Conformity Standard

2.1.2 Dedicated Sampling System for (Non-Reagent Type) Free Available Chlorine Analyzer

Function: Used for application having high pressure and large flow rate.
Refer to GS 12A00V02-01E.

2.2 Characteristics

(% display shows value relative to the upper limit of a range.)

Repeatability: 2 %

Linearity: ±5 %

Drift: Zero drift; ±1 % / month
Span drift; -10 % / month

Response time: Approx. 2 min (90% response time)

Temperature compensation error (water temperature): ±3% (Temperature compensation range : 0 to 40°C)

Ambient temperature effects: ±0.5% / 10°C

Power variation effects: ±0.5% / 10% of rated voltage

Combined chlorine effects of the combined chlorine insensitive version:
Approx. 30% of combined chlorine concentration

Model ST401G refers only to a sampling system and does not include a free available chlorine analyzer and/or a pH meter (sensor,holder,converter and ultrasonic oscillator). (Instrument should be purchased separately.)

Note that the ST401G Sampling System accepts the following models of note 1 or note 2 only, and depending on system configuration.

Note 1: Non-reagent type free available chlorine analyzer (refer to GS 12F5A1-E)
When ordering, option code "/ST" (integration into ST401G sampling system) must be specified.
Note 2: 4-wire type pH converter system (refer to GS 12B7C1-E, GS 12B07C05-01E, GS 12B07B02-E,GS 12J05C02-00E)

pH sensor:	PH8EFP-03-TN-TT1-N-T*A (when suffix code of "-PH4", "-PF4" specified.)
	PH8EFP-03-TN-TT3-N-T*A (when suffix code of "-PH4", "-PF4" and option code of "/TT3" specified.)
	PH8EFP-03-TN-TT1-N-G*A (when suffix code of "-PH5", "-PF5" specified.)
	PH8EFP-03-TN-TT3-N-G*A (when suffix code of "-PH5", "-PF5" and option code of "/TT3" specified)
pH holders:	PH8HF-PP-JPT-T-NN-NN*A (without cleaning system)
	PH8HF-S3-JPT-T-NN-NN*A (without cleaning system)
	PH8HF-PP-JPT-T-S3-C1*A (with ultrasonic cleaning)
	PH8HF-S3-JPT-T-S3-C1*A (with ultrasonic cleaning)
pH converter:	PH400G-☐-EA*B (when suffix code of "-PH4", "-PF4" specified.)
	PH450G-A-E (when suffix code of "-PH5", "-PF5" specified.)
Ultrasonic oscillator:	PUS400G-NN-NN-☐-E (which power supply rating should be same as the pH converter.)

Note 3: Power supply rating of non-reagent type free available chlorine analyzer should be same as the pH converter.
Note 4: Specify if needed, instead of the standard stanchion made of carbon steel.
Note 5: Available only when the suffix code "-FC4","-PH4" or "-PH5" is specified.
Note 6: Available when free available chlorine analyzer is specified singly or in combination with pH meter, by suffix code, "-FC4", "-PF4" or "-PF5."
Note 7: Available when free available chlorine analyzer is specified singly by suffix code, "-FC4." An arrester is supplied automatically with this option.

2.3.3 Spare Parts

Name	Part No.	Description	Q´ty	Recommended replacement interval (*)
Indicator Electrode (Rotating electrode)	K9332MB	Gold electrode	1	Yearly
Indicator Electrode (Rotating electrode)	K9334JP	Gold alloy indicator electrode	1	Yearly
Counter Electrode	K9332MK	Silver chloride electrode	1	(*1)
Ceramic Beads	K9332ZP	For cleaning general type indicator electrode, 2 bags	1	Yearly
Glass Beads	K9332ZJ	For cleaning combined chlorine insensitive type indicator electrode, 2 bags / 1Q' ty	1	Yearly
Polishing Powder (Alumina)	K9088PE	For polishing indicator electrode	1	-
Brush	K9332JX	Part for electrode mechanism	1	2 years
Slip Ring	K9332JZ	Part for electrode mechanism	1	2 years
Fuse	A1111EF	2A	1	Yearly (*2)
Driven Shaft Assembly	K9334JV	Part for electrode mechanism	1	3 years
O-Ring	Y9115XB	Part for electrode mechanism	1	3 years
Drive Belt	L9804UK	Part for electrode mechanism	1	3 years
Motor Assembly (100 V)	K9334JY	Part for electrode mechanism	1	3 years
Motor Assembly (110 V)	K9334VQ	Part for electrode mechanism	1	3 years
Motor Assembly (200 V)	K9334VR	Part for electrode mechanism	1	3 years
Motor Assembly (220 V)	K9334VS	Part for electrode mechanism	1	3 years
Gear Head (100 V/110 V)	K9332JP	Part for electrode mechanism	1	3 years
Gear Head (200 V/220 V)	K9334VA	Part for electrode mechanism	1	3 years
Activated Charcoal Filter	L9862AY	For zero calibration	1	Yearly

(*) Replacement intervals vary depending on the application.
(*1) At the time of damage.
(*2) Fuse may be used more than one year, we recommend periodical replace for planning maintenance.

6. OPERATION

6.1 Preparation for Operation

6.1.1 Inspecting Piping and Cable Installation Condition

Confirm that the piping and wiring to the FC400G free available chlorine analyzer have been correctly installed. For details of wiring, refer to Sec. 3.3.

6.1.2 Filling with Ceramic Beads for Electrode Polishing

Surface contamination of the indicator electrode results in measured value error. To avoid contamination-caused error, the electrode surface is continuously polished by ceramic beads during FC400G operation.

Ceramic beads are not filled into the beads case at factory shipment. Thus, pour the ceramic beads provided in the accessory box into the beads case as follows before starting the FC400G.

The combined chlorine insensitive version uses glass beads.

Before operation, ceramic beads are filled into the beads case of the detector.

[How to fill the ceramic beads]

Unscrew two fixing screws at the bottom of the electrode mechanism block (see Figure 6.3) to remove the measuring tank.

The ceramic beads are normally filled up to the bottommost notch of the beads case when the indicator electrode is inserted.

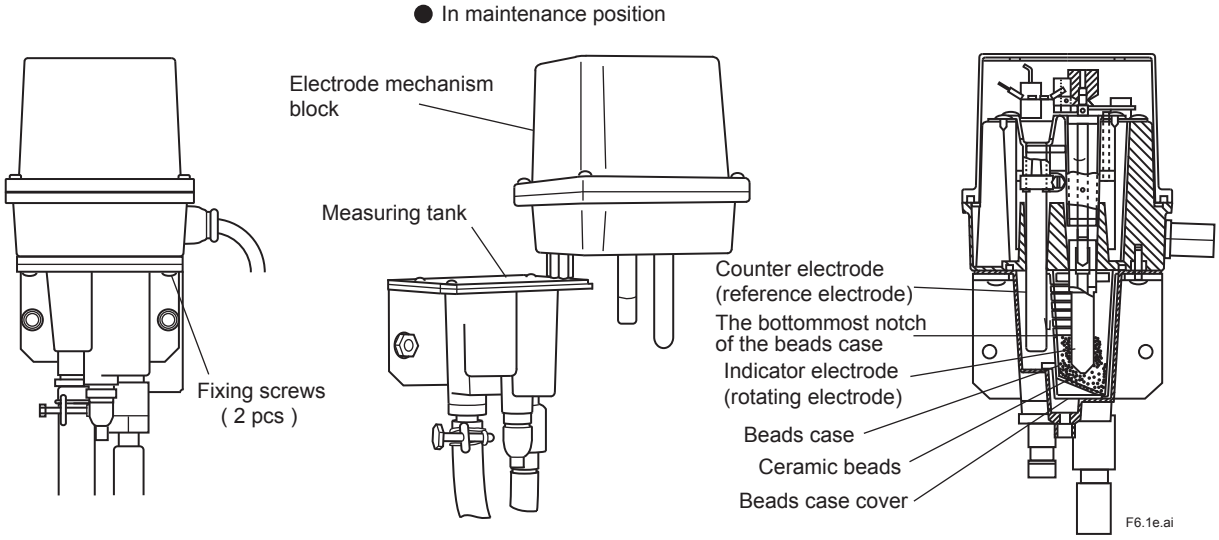

Figure 6.1 Measuring Tank Parts and Beads Case

(2) Removing the Indicator Electrode
Remove the electrode mechanism block cover from the detector. Hold the gears so that the drive shaft does not turn and remove the indicator electrode. The electrode is screwed into the drive shaft; turn the electrode counterclockwise. In so doing, do not touch the brush. Also, exercise care so that you do not touch the electrode surface of the indicator electrode.

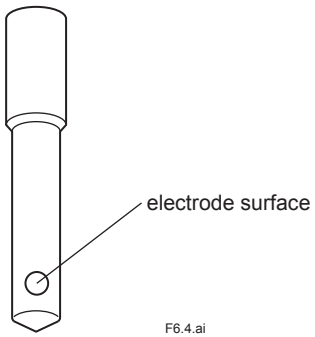

Figure 6.4 Appearance of the Indicator Electrode

(3) Polishing the Electrode Surface of the Indicator Electrode
Spread the provided abrasive (alumina) onto dampened gauze and thoroughly clean the electrode surface using such gauze so that any contamination such as oil and grease is completely removed. Then wash off any abrasives adhering to the electrode in clean running water.
After polishing and cleaning, confirm that contamination has been completely removed. The clean electrode surface must be uniformly wetted.

Note: Polish the electrode surface (gold electrode) by following the instructions below when it has become corrugated or deformed from the original shape (about 3 mm in diameter).
Polish the electrode surface with sandpaper (about #600) until the surface becomes finally rounded. Then, polish it with sandpaper (about #2000), and lastly with polishing powder (alumina). Make sure the electrode surface is clean and then install the indicator electrode.
Reduce the amount of ceramic beads if the electrode has deformed greatly. The ceramic beads should be filled up to 5 mm under the bottommost notch of the beads case when the indicator electrode is inserted.

(4) Installing the Indicator Electrode
Hold the gears so that the drive shaft does not turn, and sufficiently screw the electrode into the shaft. During installation, exercise care not to touch the electrode surface.

Note: Polish the electrode surface again if you have touched it.

(5) Attach the electrode mechanism cover. Then, set the electrode mechanism block to the measuring tank in place and fasten it using the fixing screws. Finally, use the <CELL> mode in the operation level to rotate the electrode.

6.1.5 Supplying Power

Before supplying power, check that the fuse holder cap in the converter is not loose.

A power switch in the power line to the FC400G is used to turn power ON / OFF (the FC400G does not have any internal power switch). Be careful not to turn on the power and cause an accident with the indicator electrode or belt used to rotate it when the cover is removed or the electrodes are parked in the maintenance position shown in Figure 6.3

(Note) When power is supplied, the instrument enters measurement mode.

When the electrode stops rotating, the CELL lamp extinguishes.

Remove the electrode mechanism block from the measuring tank and set up the block as shown in Figure 8.2. The electrode mechanism block is fixed to the measuring tank using two screws at the lower part of the mechanism block.

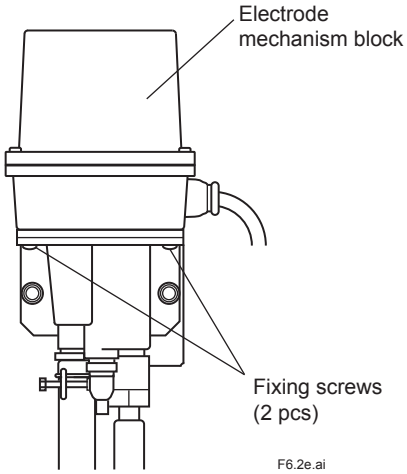

Figure 8.1 Electrode Mechanism Block Fixing Screws

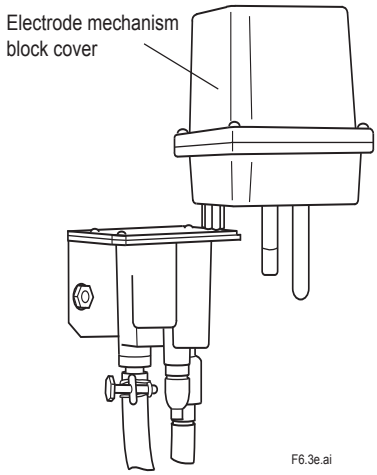

Figure 8.2 Under Maintenance

(2) Removing the Indicator Electrode
Remove the electrode mechanism block cover from the detector. Hold the gears so that the drive shaft does not turn and remove the indicator electrode. The electrode is screwed into the drive shaft; turn the electrode counterclockwise. In so doing, do not touch the brush. Also, exercise care so that you do not touch the electrode surface of the indicator electrode.

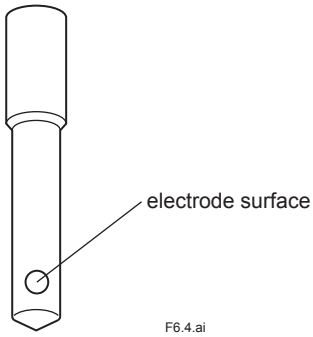

Figure 8.3 Appearance of the Indicator Electrode

(3) Polishing the Electrode Surface of the Indicator Electrode
Spread the provided abrasive (alumina) onto dampened gauze and thoroughly clean the electrode surface using such gauze so that any contamination such as oil and grease is completely removed. Then wash off any abrasives adhering to the electrode in clean running water.
After polishing and cleaning, confirm that contamination has been completely removed.
The clean electrode surface must be uniformly wetted.

IMPORTANT

Polish the electrode surface (gold electrode) by following the instructions below when it has become corrugated or deformed from the original shape (about 3 mm in diameter).
Polish the electrode surface with sandpaper (about #600) until the surface becomes finally rounded. Then, polish it with sandpaper (about #2000), and lastly with polishing powder (alumina). Make sure the electrode surface is clean and then install the indicator electrode. Reduce the amount of ceramic beads if the electrode has deformed greatly. The ceramic beads should be filled up to 5 mm under the bottommost notch of the beads case when the indicator electrode is inserted.

(4) Installing the Indicator Electrode
Hold the gears so that the drive shaft does not turn, and sufficiently screw the electrode into the shaft. During installation, exercise care not to touch the electrode surface.

Note: Polish the electrode surface again if you have touched it.

8.1.2 Cleaning the Ceramic Beads and Measuring Tank

Contaminated ceramic beads reduces the effects of cleaning of the indicator electrode, and may possibly cause electrode contamination.

Clean the ceramic beads periodically. Also, simultaneously clean the measuring tank.

Clean them as follows:

(1) Turn OFF the power switch provided in the power line or remove the fuse provided, in the converter to stop the free available chlorine analyzer.

Note: Be alert to the fact that even if the fuse is removed, live voltage remains on one side of the AC power line.

(2) Unscrew two screws fixing the electrode mechanism block to remove the mechanism block from the measuring tank.

(3) Remove the beads case, containing the ceramic beads, from the measuring tank. In so doing, remove the beads case cover together with the beads case.

(4) Clean the measuring tank.
Using a brush and neutral detergent, sufficiently remove contamination from the measuring tank. For adhesion of manganese or iron, use diluted hydrochloric acid. Finally, wash off the detergent from the measuring tank using water.

Note: Never attempt to use organic solvent for cleaning,

(5) Pour the ceramic beads into another container, remove contamination using diluted hydro chlorine acid, and sufficiently wash the beads with water.

(6) Clean beads case, and beads case cover.
For the beads case and beads case cover, clean both in the same manner as measuring tank cleaning in item (4).

Note: The beads case cover may turn whitish during prolonged use; however, it causes no functional problem.

(7) Set the beads case cover onto the beads case and pour the cleaned ceramic beads into the beads case. If the beads have obviously become smaller in size (much smaller than a diameter of 1.7 to 2.3 mm), replace them with new ones.

Ceramic beads are worn in long-term use, thereby reducing the ability of polishing indicator electrode. The ceramic beads should be entirely replaced once every year.

For optimum polishing, the new ceramic beads are normally filled up to the bottommost notch of the beads case when the indicator electrode is inserted. (The polishing ability cannot be recovered by replenishing the beads only by volume reduced by wear.)

(8) Return the electrode mechanism block in place and firmly tighten the two fixing screws.

(9) Turn ON the power switch (or return the fuse in place) to restart operation.

8.1.3 Calibration

After polishing the indicator electrode, calibrate the zero point and span in the manner described in Chapter 7.

It is recommended that calibration be conducted every month in the initial stage of FC400G operation to determine the degree of contamination on the indicator electrode. This may be a guidance for determining appropriate maintenance intervals.

8.2.4 Check / Maintenance / Replacement of Motor and Gear Head

[Procedure for Checking and Maintenance]

At zero calibration time, operate the indicator electrode and check the following. (once in three months recommended)

- Check there's no irregularity in rotation speed of drive shaft. If there's any irregularity, loose the load on the shaft by loosening the screws which fix the driven shaft pulley, and recheck. If there is still irregularity, replace motor and gear head. If the irregularity doesn't reappear, check the driven shaft assembly.
- Abnormal sound from gear head (motor).
  If there's any abnormal sound, check the motor / gear head. (In principle, this should be done by Yokogawa).
  Also, approximately once in six months, check the following items as well:
- Motor rated torque and drive torque.
  In <CELL> mode, when motor is turned ON/OFF, after the ON command it should quickly reach speed. Confirm that the difference in speed of rotation between its normal status, and when load is reduced by loosening screws fixing pulley to driven shaft, is not noticeable.
  If operation is still not satisfactory, replace motor and gear head.

[Replacement procedure]

Replacement of motor and gear head should, in principle, be carried out by Yokogawa service.

If you want to do it yourself, the procedure is as follows:

- In principle, replace motor and gear head at the same time as periodic replacement of other parts. Replace complete motor assembly consisting of both motor and capacitor.
- When replacing motor assembly and gear head, first remove motor mounting plate from base.

  There are no special cautions relating to removal of, or reassembly of, motor assembly and gear head, however the parts such as electrode, brushes and drive belt removed when removing motor from mounting plate should be carefully reassembled, referring to Sec. 8.2.1 through Sec. 8.2.3, so as not to make any mistakes in reassembly.
- The terminal board within motor assembly should be set same position of "C1" and "C2 " printed on the plate, which wire color of "C1" is yellow/green and "C2" is pink/black.

10. SPARE PARTS AND CONSUMABLES

10.1 Spare Parts and Consumables List

Name	Part No.	Description	Q´ty	Recommended replacement interval*
Indicator Electrode (Rotating electrode)	K9332MB	Gold electrode	1	Yearly
Indicator Electrode (Rotating electrode)	K9334JP	Gold alloy indicator electrode	1	Yearly
Counter Electrode	K9332MK	Silver chloride electrode	1	At the time of damage
Ceramic Beads	K9332ZP	For cleaning general type indicator electrode, 2 bags	1	Yearly
Glass Beads	K9332ZJ	For cleaning combined chlorine insensitive type indicator electrode, 2 bags / 1Q' ty	1	Yearly
Polishing Powder (Alumina)	K9088PE	For polishing indicator electrode	1	-
Brush	K9332JX	Part for electrode mechanism block	1	2 years
Slip Ring	K9332JZ	Part for electrode mechanism block	1	2 years
Fuse	A1111EF	2A	1	Yearly (*1)
Driven Shaft Assembly	K9334JV	Part for electrode mechanism block	1	3 years
O-Ring	Y9115XB	Part for electrode mechanism block	1	3 years
Drive Belt	L9804UK	Part for electrode mechanism block	1	3 years
Motor Assembly (100 V)	K9334JY	Part for electrode mechanism block	1	3 years
Motor Assembly (110 V)	K9334VQ	Part for electrode mechanism block	1	3 years
Motor Assembly (200 V)	K9334VR	Part for electrode mechanism block	1	3 years
Motor Assembly (220 V)	K9334VS	Part for electrode mechanism block	1	3 years
Gear Head (100 V/110 V)	K9332JP	Part for electrode mechanism block	1	3 years
Gear Head (200 V/220 V)	K9334VA	Part for electrode mechanism block	1	3 years
Activated Charcoal Filter	L9862AY	For zero calibration	1	Yearly

* Replacement intervals vary depending on the application.
(*1) Fuse may be used more than one year, we recommend periodical replace for planning maintenance.

10.2 Spare Parts

10.2.1 Polishing Powder (K9088PE)

Used to remove contamination on the indicator electrode that cannot be removed by automatic cleaning using glass beads (ceramic beads). One bag of abrasive is provided for the FC400G.

10.2.2 Ceramic Beads (K9332ZP)

Used to replenish or replace the ceramic beads used for automatic cleaning of the indicator electrode when their amount diminishes below the specified level or their contamination can no longer be removed. The amount of the beads for replenishment or replacement differs with the FC400G operating conditions. Generally, approx. one to two bags of beads per year are required.

One bottle of ceramic beads is provided for the FC400G.

The same applies to glass beads (K9332ZJ) used in (to decrease influence of) combined chlorine insensitive version.

10.2.3 Indicator Electrode (K9332MB)

The indicator electrode is always polished with ceramic beads; it gradually wears and ultimately becomes unusable. This is the primary factor determining the life of the electrode. Recommended replacement interval of the indicator electrode is one year generally.

The abrasion-based life may be used as a guidance in providing for indicator electrode replacement. However, recommended practice is to keep one spare always available since the electrode could be inadvertently damaged or otherwise become defective.

The same applies to gold alloy indicator electrode (K9334JP) used in combined chlorine insensitive version.

Note : Refer to the following : cool storage requirements for electrically-conductive silicon grease for indicator electrode.

[Applying Electrically-conductive Silicon Grease to Indicator Electrode]

The indicator electrode needs to be electrically connected to the driven shaft.

This is achieved by applying electrically-conductive silicon grease to the tapped part of the indicator electrode.

Before use, check that this has been done. If not, apply silicon grease as follows. You can purchase 3 ml tubes of conductive silicon grease from Yokogawa, the part no. is K9044FX.

Be careful not to get this grease on the outer surface, particularly the gold surface.

Apply a small quantity (half a drop) of grease to a small flat screwdriver (about 3 mm wide blade) and apply to three equidistant places around the tapped hole, about 3 to 5 mm inside the tip.

Next screw the indicator electrode into this tapped (threaded) hole. Next unscrew the electrode and check that no grease has been extruded to the outer surface. If it has, remove it with a cloth that has been wetted with alkaline soap solution.

NOTE

If the conductive silicon grease gets on the electrode surface, then measurement accuracy is likely to be affected.

Conductive silicon grease needs to be applied only once.

10.2.4 Counter Electrode (K9332MK)

The counter electrode does not wear like the indicator electrode ; it can be continuously used without replacement.

However, recommended practice is to keep one spare always available, in case of accidental breakage.

10.2.5 Fuse (A1111EF)

Yearly fuse replacement in the converter is recommended to avoid unexpected operation stoppage.

(Note) Fuse may be used more than one year, we recommend periodical replace for planning maintenance.